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PHOSPHORUS REMOVAL EFFICIENCY UPGRADING AT MUNICIPAL WASTEWATER TREATMENT PLANTS IN THE GREAT LAKES BASIN

PHASE 1
HISTORICAL REVIEW

Technical Report

FEBRUARY 1988

Canada Ontario

Canada-Ontario Agreement Respecting Great Lakes Water Quality
L'Accord Canada-Ontario relatif à la qualité de l'eau dans les Grand Lacs

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NOTE TO PHASE 1 REPORT

All 1985 data was not available at the time of completion of the Phase 1 report. Therefore, 1985 performance was reported based on available data. These performance data were updated in the final report when all data was available. Thus, there are inconsistencies between the data reported in the Phase 1 report and in the final project report.

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1.0 INTRODUCTION AND BACKGROUND

After completion in 1969 of a six year study of pollution in the Lower Great Lakes Drainage Basin, the International Joint Commission (IJC) recommended that all phosphorus discharges be reduced to their "lowest practical level". Subsequently, a number of organizations responded to this recommendation. The Canada Water Act (1970) of the Government of Canada, called for a staged reduction in phosphorus levels in detergents to a final limit of 5 percent (by weight as P_2O_5) by 31 December 1972. The Canada-Ontario Agreement on Great Lakes Water Quality, signed in August 1971, stipulated that phosphorus removal be implemented at selected municipal wastewater treatment facilities in the Lake Erie watershed by 31 December 1973 and in the Lake Ontario watershed by 31 December 1975. The Province of Ontario stated their intention to install phosphorus removal facilities at municipal and institutional wastewater treatment plants in the Lower Great Lakes basin, as well as the Ottawa River basin, parts of the Upper Great Lakes basin and throughout the inland recreational areas.

As an initial policy, the Province of Ontario required a minimum of 80% phosphorus removal from wastewater treatment plant influent, subject to further study. In April 1972, a Great Lakes Water Quality Agreement between Canada and United States, superceded the Ontario policy and limited effluent phosphorus concentrations to a daily average of 1 mg/L, assessed on an annual average basis, for wastewater treatment plants discharging in excess of one million gallons per day (4546 m^3/d) to Lake Erie, Lake Ontario and the International section of the St. Lawrence River.

In 1978, a supplementary Great Lakes Water Quality Agreement set Target Phosphorus Loads for all of the Great Lakes basins. These loads, a result of point and non-point sources, were 11,000 tonnes/year to Lake Erie, 7,000 tonnes per year to Lake Ontario, and a total of 8650 tonnes per year to the Upper Great Lakes. In a 1983 supplement to the 1978 agreement, further loading reduction requirements were stipulated for the Lower Great Lakes drainage basins, above and beyond those achieved by meeting a 1 mg/L monthly average effluent phosphorus requirement for plants with capacity greater than 4546 m^3/d (1 MGD). More specifically, a 2000 tonne/year load reduction was required for the Lake Erie drainage basin, of which 300 tonnes/year was allocated to Canada. A 430 tonne/year (revised from 1210 tonnes/year specified in the Agreement) load reduction was required for the Lake Ontario drainage

basin, although no allocation was stated. It was also stated that the required load reductions to the Upper Great Lakes to meet Target Loads would be achieved when all plants with a greater than 4546 m^3/day (1 MGD) flow capacity complied on a monthly average basis to effluent phosphorus concentrations of less than or equal to 1 mg/L.

In response to the most recent amendment to the Canada-U.S. Agreement (October 1983), the Ontario Ministry of the Environment (MOE) has proposed to reduce total phosphorus loadings from major municipal facilities [>1 MGD (4546 m^3/d)] by 50 tonnes per year into the Lake Ontario drainage basin and by 30 tonnes/yr into the Lake Erie basin.

In order to meet the proposed reduction, a number of management strategies could be considered. These include:

i) improvements at plants which are not presently complying with the 1.0 mg/L annual objective, to ensure consistent compliance;

ii) modification to the existing method of assessing compliance, from an "annual average" to "monthly average" total phosphorus limit; and

iii) selective improvements at some plants to achieve (or maintain, if already achieving) higher levels of phosphorus removal than presently required by the MOE.

CANVIRO has undertaken this study to identify the most cost-effective phosphorus management strategy that will meet the goals of the MOE. The investigation involves three phases. These include an in-depth review of historical plant performance data (Phase 1), field evaluations at selected plants to establish the critical factors affecting phosphorus removal performance (Phase 2), and demonstration of the cost-effectiveness of the strategies proposed to achieve phosphorus removal goals (Phase 3).

This progress report presents the results of Phase 1 of the study. Section 2 presents the specific objectives of the Phase 1 study. Section 3 presents a summary of the methodologies used. Section 4 summarizes the results of the historical data review in terms of plant performance and compliance on an annual and monthly basis and with respect to phosphorus removal methods. Section 5 presents the basin flows, phosphorus loadings and aggregate average phosphorus concentrations for 1981 to 1985 and projects these to 1990. Section 6 presents a discussion of the alternative phosphorus management strategies, their effects on basin loadings and the estimated costs associated with the implementation of each strategy. Section 7 presents those plants selected for the Phase 2 field study.

2.0 OBJECTIVES OF PHASE 1 PROGRAM

The principal objectives of the Phase 1 study were to:

- Review individual plant performance histories (1981-1985) for each plant with design flow greater than 4545 m^3/day (1 MIGD) in the Great Lakes drainage basin and determine the status of these plants in relationship to meeting MOE effluent requirements for BOD_5, TSS and TP on an annual and monthly basis.
- Review individual plant phosphorus removal techniques (i.e. chemical and dosage used, point of addition, etc.) and identify possible reasons for the phosphorus removal performance reported.
- Develop management strategies that would improve plant performance and reduce basin phosphorus loadings, and project the effect of each of these strategies on basin phosphorus loadings to 1990.
- Review the advantages and disadvantages of each of the above strategies with respect to implementation costs and impacts on receiving basin loadings.
- Recommend plants for Phase 2 field analysis.

3.0 METHODOLOGY

3.1 Historical Data Review

Plant operating data for 1981-1985 were obtained from two sources. The MOE database, containing information for MOE operated plants for all five years and municipally operated plants for 1984-1985, was transferred to CANVIRO's IBM-PC system. This was supplemented by manual entry of 1981-1983 data for municipally operated plants, from "1981-1983 Wastewater Treatment Summaries for Municipally Operated Plants in Ontario".

The MOE database provided average monthly values for each operating parameter considered, as well as the number of samples on which the monthly average was based. The Wastewater Treatment Summaries supplied only annual averages for each operating parameter.

Individual plant performance histories were prepared from the available data, consisting of a 5 year (1981-1985) annual review and a 2 year (1984 and 1985) monthly review.

3.1.1 Annual Data Review

The annual data review summarized annual average and long-term average daily flows, and influent and effluent BOD_5, TSS and TP concentrations. Statistical analyses were done to determine if annual effluent BOD_5, TSS and TP concentrations for any year were significantly different from the long-term averages (if sufficient data were available). Finally, an indication of whether the plant met an annual average effluent phosphorus concentration of 1 mg/L was shown for each year. Figure 1 presents the format of the annual review.

Table 1 summarizes the equations used to calculate the values in the annual review.

Compliance of annual effluent TP concentrations to a 1 mg/L limit was indicated by a Y (yes) or N (no) for each year and for the long-term average TP concentrations. It should be noted that these indicators do not consider site-specific TP effluent requirements.

ANNUAL DATA REVIEW LOCATION BASIN

PLANT NAME
Plant Configuration
Phosphorus Removal

Plant Design Capacity (1000 m^3/day)

PARAMETER	1981	1982	1983	1984	1985	5 YEAR AVG. 81-85
Avg. Daily Flow (1000 m^3/day)						
BOD_5 - Influent (mg/L) BOD_5 - Effluent (mg/L) Annual BOD_5 Significantly Different from Mean Annual Average BOD_5?	(Y/N)					
TSS - Influent (mg/L) TSS - Effluent (mg/L) Annual TSS Significantly Different from Mean Annual Average TSS?	(Y/N)					
Total P - Influent (mg/L) Total P - Effluent (mg/L) Annual TP Significantly Different from Mean Annual Average TP? TP in Compliance?	(Y/N) (Y/N)					

I.D. - Insufficient Data

FIGURE 1 - ANNUAL DATA REVIEW FORMAT

TABLE 1. EQUATIONS FOR CALCULATION OF AVERAGES (ANNUAL AND LONG-TERM) AND STATISTICAL ANALYSES

CALCULATION:	EQUATION(S):
1. Annual Average ($\overline{X}_i$)	$\overline{X}_i = \frac{1}{n_i} \sum_{j}^{n} X_{ij}$
2. Long Term Average ($\overline{X}_A$)	$\overline{X}_A = \frac{1}{5} \sum_{i=1}^{5} \sum_{j=1}^{n_i} (\overline{X}_{ij}/n_i)$ - if monthly data is unavailable then: $\sum_{j=1}^{n_i} (\overline{X}_{ij}/n_i) = \overline{X}_i$
3. Statistical Analysis (t-distribution, 95% level of significance) $H_0 : \overline{X}_i = \overline{X}_A$ $H_i : \overline{X}_i \neq \overline{X}_A$ Reject H_0 if $t_i > t_{0.025}$	$t_i = \left\lvert \dfrac{\overline{X}_i - \overline{X}_A}{Sp_i \sqrt{\frac{1}{n_i} + \frac{1}{N}}} \right\rvert$ $Sp_i = \sqrt{\dfrac{(n_i-1)S_i^2 + (N-1)S_A^2}{(n_i + N - 2)}}$ (Degrees of Freedom)$_i = n_i + N - 2$

Where:

i = year

j = month

$\overline{X}_i$ = annual average for year i

$\overline{X}_{ij}$ = monthly average for month j, year i

X_5 = long term average

n_i = number of months of available data in year i

N = number of months of data for the 5 year period i.e. $\sum_{i=1}^{5} n_i$

S_i^2 = variance of n_i months of data for year i

S_A^2 = variance of N months of data

3.1.2 Monthly Data Review

Individual monthly data reviews were prepared to present monthly average effluent BOD_5, TSS and TP concentrations and the number of samples upon which these were based, for 1984 and 1985. These values were obtained directly from the MOE database. Figure 2 shows the monthly review format. Again, compliance indicated by a Y or N was based only on a 1 mg/L effluent requirement and did not take into account site-specific requirements.

3.2 Plant Contact and Plant Review

In order to understand and explain phosphorus removal performance at each plant, it was necessary to obtain information on phosphorus removal methods being used and plant design data. This information was acquired through direct plant contact, from material supplied by MOE, and from previous CANVIRO studies.

Project engineers from CANVIRO contacted representatives familiar with the design and operation of each of the plants. In most cases, plant contact was made by telephone. A questionnaire form (Figure 3) was utilized by the project engineer to expedite the acquisition of information on plant operation and design. Key items in the questionnaire included:

i) chemical used for phosphorus removal, usage rate, point of addition and dosage control method;

ii) availability of data on orthophosphorus and/or filtered phosphorus in plant effluents;

iii) sampling frequency and analytical methodology;

iv) major industrial contributors; and

v) average and peak daily flows, fraction of combined and separate sewers serving the plant, and frequency of plant bypasses.

Design information on MOE operated plants was extracted from the "1981 Summary of Municipal Water and Wastewater Treatment Works". Also, design summaries were available for some plants from previous CANVIRO projects. For those plants where limited design information was available, process flowsheets and key design criteria were requested from plant personnel.

MONTHLY DATA LOCATION

PLANT NAME

YEAR	MONTH	EFFLUENT BOD_5 (mg/L)	n BOD	EFFLUENT TSS (mg/L)	n TSS	EFFLUENT TP (mg/L)	n TP	IS TP IN COMPLIANCE? (y/n)
1984	JAN.							
	FEB.							
	MAR.							
	APR.							
	MAY							
	JUN.							
	JUL.							
	AUG.							
	SEP.							
	OCT.							
	NOV.							
	DEC.							
1985	JAN.							
	FEB.							
	MAR.							
	APR.							
	MAY							
	JUN.							
	JUL.							
	AUG.							
	SEP.							
	OCT.							
	NOV.							
	DEC.							

n - Number of samples

FIGURE 2 - MONTHLY DATA REVIEW FORMAT

WPCP PHOSPHORUS REMOVAL INFORMATION

PLANT:

MUNICIPALITY SERVED:

OPERATED BY: MOE ☐
MUNICIPALITY ☐

TREATMENT PROCESSES: PRIMARY ☐

BIOLOGICAL
- CONV. ACTIVATED SLUDGE ☐
- EXTENDED AERATION ☐
- HIGH-RATE ACTIVATED SLUDGE ☐
- CONTACT STABILIZATION ☐
- OTHER: ____

TERTIARY
- EFFLUENT FILTERS ☐
- STORAGE LAGOONS ☐
- OTHER: ____

DESIGN FLOW: ____ MIGPD ____ 10^3 m^3/d

ESTIMATED MAXIMUM DAILY FLOW: ____ MIGPD ____ 10^3 m^3/D

TYPE OF COLLECTION SYSTEM: SEPARATE ____ % OF SYSTEM
COMBINED ____ % OF SYSTEM

PLANT BYPASS: FREQUENCY ____ TIMES PER YEAR
ESTIMATED DURATION ____ HOURS PER EVENT
POINT OF BYPASS: AT INFLUENT WET WELL ☐
AFTER PRIMARIES ☐
OTHER: ____

POINT OF BYPASS DISCHARGE:
TO CHLORINE CONTACTOR ☐
TO OUTFALL ☐

IS BYPASS INCLUDED IN FINAL EFFLUENT SAMPLE:
YES ☐ NO ☐

PHOSPHORUS REMOVAL:

CHEMICALS USED	1984	1985	PRESENT
ALUM	☐	☐	☐
FERRIC CHLORIDE	☐	☐	☐
FERROUS SULPHATE	☐	☐	☐
FERROUS CHLORIDE	☐	☐	☐
LIME	☐	☐	☐
POLYMER (____)	☐	☐	☐
ANNUAL CHEMICAL USAGE: (Litres)	____	____	____

AVERAGE CONCENTRATION: ____ (as metal)

ESTIMATED DOSAGE: (as metal, mg/L) ____ ____ ____

DOSAGE CONTROL METHOD: MANUAL ☐
FLOW-PROPORTIONAL ☐
AUTOMATIC FLOW PROPORTIONAL ☐

POINT OF CHEMICAL ADDITION: ____

If Fe^{+2} added to aeration basins, what is aeration basin dissolved oxygen concentration (mg/L)? ____

Automatic D.O. control practised: YES ☐
NO ☐

CHEMICAL SUPPLIER: ____

CHEMICAL COST (F.O.B. Plant): ____

EFFLUENT SAMPLING INFORMATION:

NUMBER OF SAMPLES PER MONTH FOR P ANALYSIS: ____

SAMPLE TYPE: GRAB ☐
MANUAL 24-HR COMPOSITE ☐
AUTOMATIC 24-HR COMPOSITE ☐
FLOW PROPORTIONAL 24-HR COMPOSITE ☐

SAMPLE PRESERVATION: REFRIGERATION ☐
FREEZING ☐
OTHER: ____

SAMPLE LOCATION: ____

IS ANALYSIS FOR SOLUBLE TP OR ORTHO P CONDUCTED? YES ☐
NO ☐

ANALYTICAL METHODOLOGY USED: ____

LOCATION OF ANALYTICAL LABORATORY: ON-SITE ☐
CENTRAL MUNICIPAL LAB ☐
MOE LAB ☐
OTHER: ____

INDUSTRIAL CONTRIBUTORS:

MAJOR INDUSTRIAL CONTRIBUTORS (FLOW and/or BOD_5/TSS/TP):

1. ____
2. ____
3. ____
4. ____
5. ____

ESTIMATED PERCENT INDUSTRIAL FLOW: ____

IS INFLUENT AND/OR EFFLUENT HEAVY METAL CONCENTRATION DATA AVAILABLE? YES ☐ NO ☐

DESIGN SUMMARY AVAILABLE: YES ☐
NO ☐

OTHER COMMENTS RELATED TO P REMOVAL PRACTICES:

FIGURE 3 - PHOSPHORUS REMOVAL AND DESIGN QUESTIONNAIRE FORM

Individual plant reports were compiled, containing:

1. Annual Data Review
2. Monthly Data Review
3. Design Summary
4. Completed Questionnaire

Review of the data in this report allowed the project engineer, who had contacted the plant, to conduct preliminary analyses on phosphorus removal performance. Factors causing poor or extremely good removal efficiency were suggested using the ranking system presented in Figure 4. These factors are described in more detail in Table 2.

3.3 Basin Flows, Loadings and Aggregate Average Phosphorus Concentrations

Individual plant phosphorus loadings (tonnes P/year) to the receiving basins were calculated for 1981 to 1985 based on total plant flows and average effluent phosphorus concentrations. Grouping of individual plants according to their receiving basin (Lake Erie, Lake Huron, Lake Ontario and St. Lawrence River, and Lake Superior), shown in Table 3, enabled calculation of total phosphorus loadings to the basin. An IBM-PC BASIC program utilized the equations of Table 4 to generate these values.

Using the total basin flows, defined by the sum of the individual plants total flow for a given basin, aggregate average phosphorus concentrations (mg TP/L) were calculated. This was the total basin loading divided by the total basin flow and represented the average phosphorus concentration in the flows entering the receiving basin.

Using linear regression techniques, basin flows were predicted for each basin for 1986-1990. The predicted flows were compared to the total design capacity of the basin in order to determine when design flow capacity in each basin WPCPs would be exceeded. By using the basin flows, and assuming no change in treatment efficiency from 1985 performance (i.e. constant effluent phosphorus concentrations), the basin phosphorus loadings were also projected to 1990.

1. FOR PLANTS NOT ACHIEVING TP <1 mg/L, RANK FACTORS, IN ORDER OF IMPORTANCE, WHICH CONTRIBUTE TO POOR P REMOVAL PERFORMANCE:

CAUSE	RANK (1 = MOST IMPORTANT)
i) High Clarifier Surface Loading	________
ii) Low P Removal Chemical Dosage	________
iii) High Influent P Concentration	________
iv) Industrial Waste Factors	________
v) Poor Sludge Settleability	________
vi) Poor Dosage Control	________
vii) Sludge Management Problems	________
viii) Sampling Problem	________
ix) Analytical Problem	________
x) Bypassing	________
xi) Infiltration/Inflow or Combined Sewers	________
xii) Others (please specify)	
________	
________	
________	
________	
________	
________	
________	
________	

2. FOR PLANTS CONSISTENTLY ACHIEVING TP <<1 mg/L, RANK FACTORS, IN ORDER OF IMPORTANCE, WHICH CONTRIBUTE TO SUPERIOR P REMOVAL PERFORMANCE:

CAUSE	RANK (1 = MOST IMPORTANT)
i) Low Clarifier Surface Loading	________
ii) High P Removal Chemical Dosage	________
iii) Low Influent P Concentration	________
iv) Industrial Waste Factors	________
v) Good Sludge Settleability	________
vi) Good Dosage Control	________
vii) Final Effluent Polishing by Filtration	________
viii) Final Effluent Polishing by Tertiary Ponds	________
ix) Polymer Addition	________
x) Superior Plant Operation	
xi) Others (please specify)	
________	
________	
________	
________	
________	
________	
________	
________	

FIGURE 4 - RANKING SYSTEM FOR SUGGESTING GOOD OR POOR PLANT PHOSPHORUS REMOVAL PERFORMANCE

TABLE 2. DESCRIPTION OF FACTORS CAUSING SUPERIOR OR INFERIOR PHOSPHORUS REMOVAL PERFORMANCE

FACTORS CONTRIBUTING TO POOR P REMOVAL PERFORMANCE	DESCRIPTION	FACTORS CONTRIBUTING TO SUPERIOR P REMOVAL PERFORMANCE	DESCRIPTION
i) High Clarifier Surface Loading	-Plant flows exceed design flow capacity -High peak flows (I/I)	i) Low Clarifier Surface Loading	-Plant flows much less than design flow capacity -Low clarifier design surface loading
ii) Low P Removal Chemical Design	-Dosing much less than stoichiometric dosage required, i.e. molar ratio Metal:P<<1	ii) High P Removal Chemical Dosage	-Dosing at much greater concentrations than stoichiometric ratio
iii) High Influent P Concentration	-P concentration greater than about 8 mg/L	iii) Low Influent P Concentration	-P concentration less than about 3 mg/L
iv) Industrial Waste Factors	-Industrial contribution of contaminants suspected to affect phosphorus precipitation, or cause poor sludge settleability or contribute high P load	iv) Industrial Waste Factors	-Industrial contribution of metals aiding in the precipitation of phosphorus
v) Poor Sludge Settleability	-Evidence of sludge solids carry-over from secondary clarifiers	v) Good Sludge Settleability	-Good suspended solids removal (i.e. <10 mg/L in effluent) at typical clarifier loadings
vi) Poor Dosage Control	-Highly variable influent P concentrations and no dosage control	vi) Good Dosage Control	-Regular adjustment of chemical dosage to influent P concentration (manual or automatic)
vii) Sludge Management Problems	-Limited capacity of sludge handling processs (digesters, dewatering equipment, storage, haulage) causes excessive solids losses in effluent	vii) Final Effluent Polishing by Filtration	-Improved removal of suspended solids, resulting in removal of non-filtrable P
viii) Sampling Problem	-Infrequent sampling, biased sampling methods (e.g. at peak hours only), etc.	viii) Final Effluent Polishing by Tertiary Ponds	-Improved removal of suspended solids, resulting in removal of non-filtrable P
ix) Analytical Problem	-Limitations of "kits" for P removal analysis -Inexperience of operators to perform laboratory analyses	ix) Polymer Addition	-Addition of polymer for improved solids and phosphorus removal
x) Bypassing	-Frequent bypassing, untreated wastewater included in final effluent sample	x) Superior Plant Operation	-Good operator understanding and control of plant operational parameters
xi) Infiltration/Inflow on Combined Sewers	-High peak flows, solids carry-over and/or bypassing		

TABLE 3. GROUPING OF PLANTS BY DRAINAGE BASIN

LAKE ERIE	LAKE HURON	LAKE ONTARIO/ST. LAWRENCE	LAKE SUPERIOR
Amherstburg WPCP	Barrie WPCP	Belleville WPCP	Thunder Bay WPCP
Brantford WPCP	Bradford WPCP	Brockville WPCP	
Galt WPCP (Cambridge)	Collingwood WPCP	Burlington WPCP	
Hespeler WPCP (Cambridge)	Esten Lake WPCP (Elliot Lake)	Caledon WPCP (Bolton)	
Preston WPCP (Cambridge)	Plant Two (Elliot Lake)	Campbellford WPCP	
Chatham WPCP	Goderich WPCP	Cobourg WPCP No.1	
Dresden WPCP	Hanover WPCP	Cornwall WPCP	
Dunnville WPCP	Huntsville WPCP	Dundas WPCP	
Fergus WPCP	Midland WPCP	Anger Ave. WPCP (Fort Erie)	
Guelph WPCP	North Bay WPCP	Baker Rd. WPCP (Grimsby)	
Ingersoll New WPCP	Orillia WPCP	Acton WPCP & Lagoon (Halton Hills)	
Kitchener WPCP	Owen Sound WPCP	Georgetown WPCP (Halton Hills)	
Leamington WPCP	Parry Sound WPCP	Woodward Ave. WPCP (Hamilton)	
Adelaide WPCP (London)	Port Elgin WPCP	Iroquois WPCP	
Greenway WPCP (London)	Sault Ste. Marie WPCP	Kingston WPCP	
Oxford WPCP (London)	Sturgeon Falls WPCP	Kingston TWP WPCP	
Pottersburg WPCP (London)	Sudbury WPCP	Highland Creek WPCP (Metro Toronto)	
Vauxhall WPCP (London)	Thunder Bay WPCP	Humber WPCP (Metro Toronto)	
Belle River-Maidstone WPCP	Hamner, Val-Caron, Val-Therese WPCP (Valley East)	Main WPCP (Metro Toronto)	
Corunna P.V. Plant (Moore)		North Toronto WPCP (Metro Toronto)	
Paris WPCP	Mikkola WPCP (Walden)	Milton WPCP	
Sarnia WPCP	Walkerton WPCP	Clarkson WPCP (Mississauga)	
Simcoe WPCP	Wasaga Beach WPCP	Lakeview WPCP (Mississauga)	
St. Thomas WPCP		Napanee WPCP	
Stratford WPCP		Port Darlington WPCP (Newcastle)	
Tillsonburg WPCP		Newmarket WPCP	
Wallaceburg WPCP		Stamford WPCP (Niagara Falls)	
Waterloo WPCP		South East WPCP (Oakville)	
Little R. WPCP (Windsor)		South West WPCP (Oakville)	
Westerly WPCP (Windsor)		Orangeville WPCP	
Woodstock WPCP		Harmony Cr. WPCP No.1 (Oshawa)	
		Harmony Cr. WPCP No.2 (Oshawa)	
		Peterborough WPCP	
		York-Durham WPCP (Pickering)	
		Picton WPCP	
		Seaway WPCP (Port Colborne)	
		Port Hope WPCP	
		Prescott-Edwardsburgh WPCP	
		Port Dalhousie WPCP (St. Catharines)	
		Port Weller WPCP (St. Catharines)	
		Trenton WPCP	
		Welland WPCP	
		Corbett Cr. WPCP (Whitby)	
		Pringle Cr. WPCP No.1 (Whitby)	
		Pringle Cr. WPCP No.2 (Whitby)	

TABLE 4. EQUATIONS FOR CALCULATION OF BASIN LOADINGS AND AGGREGATE AVERAGE CONCENTRATIONS

DESCRIPTION	EQUATION
TP Loading in year i for plant x - monthly data available.	$L_{ix} = 0.365 \sum_{j=1}^{n_{ix}} Q_{ijx} P_{ijx}$ [t/yr]
TP Loading in year i for plant x - only annual averages available.	$L_{ix} = 0.365\ Q_{ix} P_{ix}$ [t/yr]
TP Loading in year i for a Drainage Basin	$L_i = \sum_{x=1}^{m} L_{ix}$ [t/yr]
Aggregate Average TP Concentration for year i, for a Drainage Basin	$P_i = L_i / \sum_{x=1}^{n} Q_{ix}$ [mg/L]

Where:

Q_{ijx} = total flow for year i, month j, plant x

P_{ijx} = phosphorus concentration in year i, month j for plant x

Q_{ix} = total flow for year i, plant x

P_{in} = phosphorus concentration for year i, plant x

n_{ix} = number of months of available data in year i for plant x

m = number of plants in basin

3.4 Phosphorus Management Strategies

Based on discussions with the Project Steering Committee, the following strategies were considered to reduce basin phosphorus loadings in each of the Lake Erie and Lake Ontario/St. Lawrence drainage basins:

Scenario 0:
Basin loadings as actually experienced in 1984 and 1985.

Scenario 1:
All plants comply with effluent TP $\leq$ 1 mg/L on an annual average basis, or their site-specific requirements.

Scenario 2:
All plants comply with effluent TP $\leq$ 1 mg/L on a monthly average basis, or their site-specific requirements.

Scenario 3:
All plants with design capacity >100,000 m^3/d in the Lake Erie drainage basin and >200,000 m^3/d in the Lake Ontario drainage basin comply with effluent TP $\leq$ 0.9 mg/L on a monthly average basis. All other plants comply on a monthly average basis with TP $\leq$ 1 mg/L, or their site-specific requirements.

Scenario 4:
All plants comply with effluent TP $\leq$ 0.9 mg/L on a monthly average basis, or their site-specific requirements.

For each management strategy evaluated, the loading reduction to each receiving basin (Lake Erie and Lake Ontario/St. Lawrence) which would have resulted in 1984 and 1985 was calculated. The projected basin loadings for 1986 to 1990 were estimated and compared to the projected loadings which would occur without any change in phosphorus removal efficiency (baseline case). The estimated additional costs of each phosphorus removal strategy for the years 1984 and 1985 were calculated.

3.4.1 Basin Loading Reduction

The effect that each management strategy would have on basin loading was determined using a modified form of the IBM-PC program described in Section 3.3. Hypothetical loads for 1984 and 1985 for each scenario from each individual plant were calculated by adjusting the effluent phosphorus concentrations which did not comply with the stated requirements of that scenario. For the scenario based on annual compliance (Scenario 1), the hypothetical load was calculated by adjusting the annual average effluent phosphorus concentration to 1 mg/L if the particular plant under consideration did not meet that requirement for either 1984 or 1985. If a particular plant was already complying with the annual requirement of 1 mg/L, no change was made to the discharge loading of phosphorus from that plant (that is, its performance was not downgraded to 1 mg/L if it was already discharging at a lower concentration). For the scenarios based on monthly compliance (Scenarios 2, 3 and 4), the hypothetical load was calculated by adjusting the average monthly effluent phosphorus concentration to 1 mg/L or 0.9 mg/L as required for those months in 1984 and 1985 that did not already meet that requirement. As in Scenario 1, plant performance was not downgraded for months that were already meeting the discharge limits specified by the particular scenario being evaluated. No consideration was given to the fact that plants were not actually attempting to meet monthly requirements in 1984 and 1985.

From the hypothetical loads for 1984 and 1985 for each plant, basin loadings and aggregate average phosphorus concentrations were calculated (as described in Section 3.3) for each scenario. Furthermore, using the predicted flows and the assumption that 1985 treatment efficiency is maintained, hypothetical basin loadings were predicted for 1986-1990 after implementation of each scenario. The basin loading reduction resulting from each scenario was compared to the "Base Load", defined as the actual 1983 phosphorus loadings for the Lake Erie and the Lake Ontario/St. Lawrence drainage basins.

3.4.2 Remediation

For every plant not presently complying with the phosphorus removal requirements suggested by the individual phosphorus removal strategies evaluated, some improvement in phosphorus removal efficiency would be required. These performance improvements will generally result in increased plant

operating costs. In order to estimate operating cost increases associated with each management strategy in each receiving basin considered (Lake Erie and Lake Ontario/St. Lawrence River), remediation methods were developed for each plant affected by the strategies proposed.

The remedial measures which would be implemented in each plant were based on the plant operating evaluations conducted in Phase 1. Generally, remediation involved an increase in chemical dosage. Remediation was applied only in those plants that exceeded the effluent criteria imposed for the specific scenario being evaluated and only for the time period (months or years) that was exceeded for that scenario. No consideration was given to the fact that plants were not attempting to meet monthly compliance requirements in 1984 and 1985. The objective of Phases 2 and 3 of the program are to better define specific remediation methods which could be applied to improve plant phosphorus removal performance. Therefore, fine-tuning of the remediation methods will result from the completion of these phases of the investigation.

The following assumptions were made in determining the extent of remediation required at each plant:

i) Chemical dosage increase was the most cost-effective method for plants already using chemical phosphorus removal.

ii) Implementation of chemical addition ($FeCl_3$) for phosphorus removal at plants not presently using phosphorus removal would be an effective method of improving P removal efficiency at these plants.

iii) Dosage increase for secondary plants using phosphorus removal was based on an increase equivalent to the metal-to-phosphorus weight ratio used in 1984 and 1985 and the difference between the effluent requirement and the operating point.

iv) For primary plants using chemicals for phosphorus removal, it was assumed that improved solids removal by 0.5 mg/L polymer addition would achieve the desired effluent P requirement.

v) Chemical dosage to secondary plants not presently using phosphorus removal was based on the amount of phosphorus removed without chemicals and the effluent phosphorus concentrations. Also, chemical addition was only considered to be required during those periods that the effluent concentration exceeded the imposed limits.

3.4.3 Costs of Remediation

In order to implement the improvements at each plant, costs would be incurred due to additional chemical usage (metal and/or polymer), and additional sludge production. Since prorated capital costs for equipment would be relatively small compared to chemical and sludge handling costs, no capital cost component was included.

The following assumptions were used to determine costs required at each plant:

i) Costs for ferric, ferrous and alum addition were based on reported costs, FOB the plant (Reported 1984 and 1985 costs).

ii) Polymer costs were assumed to be \$2.50/kg FOB the plant. No additional labour, power or maintenance costs were assigned to the polymer make-up and feed system.

iii) Increased sludge production from increased chemical dosage was based on the averages of ranges of values suggested by U.S. EPA (1976) as 4.52-2.89 mg sludge/mg Al (avg. 3.71) and 2.70-1.92 mg sludge/mg Fe (avg. 2.31).

iv) No increase in sludge handling capacity (digesters, dewatering equipment) was provided.

v) Sludge disposal costs were based on \$2.50/m^3 wet sludge for land disposal; \$50/tonne dry solids for dewatering and disposal, \$150/tonne for dewatering and incineration, and \$200/tonne for dewatering, heat treatment and incineration. Costs at each plant were based on the actual sludge disposal methods in use at that plant.

vi) For primary plants, it was assumed that improved solids removal by polymer addition would achieve a 1 mg/L effluent phosphorus requirement. Therefore, capital costs for upgrading to full secondary treatment were not considered.

As noted in Section 3.4.2, the objectives of Phases 2 and 3 of the program are to develop and demonstrate improved phosphorus control techniques which would improve phosphorus removal efficiencies at existing facilities at low cost. The results of Phases 2 and 3 will be used to improve the preliminary remediation costs presented in this Phase 1 report.

4.0 SUMMARY OF PLANT PERFORMANCE

4.1 Historical Data Review

4.1.1 General

In 1985, there were 96 municipal treatment plants with design capacity greater than 4546 m^3/day (1 MGD) discharging to the International section of the Great Lakes drainage basin. These included 44 plants in the Lake Ontario/St. Lawrence drainage basin, 31 in the Lake Erie drainage basin, 20 in the Lake Huron drainage basin and 1 in the Lake Superior drainage basin. Of these, 83 plants presently provide secondary treatment, while 13 provide only primary treatment. None of the 4 sewage lagoons in the Great Lakes Basin with capacities greater than 4546 m^3/day (1 MGD) (Strathroy lagoon, Listowel lagoon, Kincardine lagoon and Lindsay lagoon) were included in the review. All of the plants, their design capacity and type, and the chemicals used for phosphorus removal at each plant are listed in Tables 5 to 7. Figure 5 indicates the location of each plant.

Average daily flow and average effluent quality characteristics for 1981 to 1985, obtained from the annual performance data review prepared for each plant, are summarized in Tables 8 to 10. Also included in these summary tables is the 5 year long-term average daily flow and effluent quality for each plant.

4.1.2 Plant and Basin Summaries of Compliance

A number of summaries were developed to illustrate the compliance histories of individual plants. Compliance has been assessed in two ways in this report:

i) Annual Compliance - A plant was considered to be "in compliance" if the annual average effluent concentration of BOD_5, TSS or TP did not exceed the MOE Guidelines for the year being evaluated.

ii) Monthly Compliance - A plant was considered to be "in compliance" if the monthly average effluent concentration of BOD_5, TSS or TP did not exceed the MOE Guidelines for <u>any month</u> in the year being evaluated. (That is, a plant was considered to be out-of-compliance for the 1984 if the monthly average effluent concentration exceeded the MOE Guideline during any month in 1984.)

TABLE 5. PLANTS IN THE LAKE ERIE DRAINAGE BASIN - DESIGN FLOW, PLANT TYPE AND CHEMICALS USED FOR PHOSPHORUS REMOVAL

PLANT	DESIGN FLOW (10^3 m^3/d)	PLANT TYPE	CHEMICAL PRESENTLY USED FOR PHOSPHORUS REMOVAL
Amherstburg WPCP	4.546	Primary, phosphorus removal - continuous	Ferric Chloride
Brantford WPCP	81.828	Conventional activated sludge, phosphorus removal - continuous	Ferrous Chloride
Galt WPCP (Cambridge)	36.641	Conventional activated sludge, phosphorus removal - continuous	Ferric Chloride
Hespeler WPCP (Cambridge)	9.319	High rate activated sludge, phosphorus removal - continuous	Ferric/Ferrous Chloride
Preston WPCP (Cambridge)	16.866	Conventional activated sludge, phosphorus removal - continuous	Ferric Chloride
Chatham WPCP	35.913	Conventional activated sludge, phosphorus removal - continuous, effluent polishing	Ferrous Chloride
Dresden WPCP	4.546	Extended aeration, phosphorus removal - continuous	Aluminum Chloride
Dunnville WPCP	7.728	Conventional activated sludge, phosphorus removal - continuous	Ferrous Chloride
Fergus WPCP	5.001	Conventional activated sludge, phosphorus removal - continuous	Ferrous Chloride
Guelph WPCP	54.552	Conventional activated sludge, phosphorus removal - continuous, effluent polishing	Alum
Ingersoll New WPCP	6.819	Conventional activated sludge, phosphorus removal - continuous	Ferrous Chloride
Kitchener WPCP	122.742	Conventional activated sludge, phosphorus removal - continuous	Ferrous Sulphate
Leamington WPCP	19.093	Conventional activated sludge, phosphorus removal - continuous	Ferric Chloride
Adelaide WPCP (London)	18.184	Conventional activated sludge, phosphorus removal - continuous	Ferrous Chloride
Greenway WPCP (London)	123.333	Conventional activated sludge, phosphorus removal - continuous	Ferrous Chloride
Oxford WPCP (London)	5.455	Conventional activated sludge, phosphorus removal - continuous	Ferrous Chloride
Pottersburg WPCP (London)	22.048	Conventional activated sludge, phosphorus removal - continuous	Ferrous Chloride
Vauxhall WPCP (London)	20.912	Conventional activated sludge, phosphorus removal - continuous	Lime
Belle River-Maidstone WPCP	6.819	Extended aeration, phosphorus removal - continuous	Alum
Corunna P.V. Plant (Moore)	4.546	Extended aeration, phosphorus removal - continuous	Alum
Paris WPCP	7.046	Extended aeration, phosphorus removal - continuous	Ferric Chloride
Sarnia WPCP	65.917	Primary, phosphorus removal - continuous	Ferric Chloride/ Polymer in Summer
Simcoe WPCP	15.546	Conventional activated sludge, phosphorus removal - continuous, effluent polishing	Ferric Chloride
St. Thomas WPCP	40.914	Conventional activated sludge, phosphorus removal - continuous	Alum
Stratford WPCP	27.276	Conventional activated sludge, phosphorus removal - continuous, effluent polishing	Alum
Tillsonburg WPCP	8.183	Conventional activated sludge, phosphorus removal - continuous	Alum
Wallaceburg WPCP	6.819	Conventional activated sludge, phosphorus removal - continuous	Ferric Chloride
Waterloo WPCP	45.460	Conventional activated sludge, phosphorus removal - continuous	Ferrous Chloride
Little River WPCP (Windsor)	36.368	Conventional activated sludge, phosphorus removal - continuous	Aluminum Chloride
Westerly WPCP (Windsor)	163.656	Conventional activated sludge, phosphorus removal - continuous	Alum
Woodstock WPCP	36.368	Conventional activated sludge, phosphorus removal - continuous	Ferric Chloride

TABLE 6. PLANTS IN THE LAKE ONTARIO/ST. LAWRENCE DRAINAGE BASIN - DESIGN FLOW, PLANT TYPE AND CHEMICALS USED

PLANT	DESIGN FLOW (10^3 m^3/d)	PLANT TYPE	CHEMICAL PRESENTLY USED FOR PHOSPHORUS REMOVAL
Belleville WPCP	29.454	Conventional activated sludge, phosphorus removal - continuous	Ferric/Ferrous Chloride
Brockville WPCP	25.571	Primary, phosphorus removal, continuous	Ferric Chloride
Skyway WPCP (Burlington)	93.193	Conventional activated sludge, phosphorus removal - continuous	Ferric Chloride
Bolton WPCP (Caledon) (up to 1985)	4.546	Conventional activated sludge, phosphorus removal - continuous	No Chemical Used
Campbellford WPCP	5.910	Conventional activated sludge	No Chemicals Used
Cobourg WPCP No.1	16.047	Conventional activated sludge	No Chemicals Used
Cornwall WPCP	37.505	Primary, phosphorus removal - continuous	Alum, Polymer
Dundas WPCP	18.184	Conventional activated sludge, phosphorus removal - continuous, effluent polishing	Alum
Anger Ave. WPCP (Fort Erie)	16.366	Primary, phosphorus removal - continuous	Ferric Chloride
Baker Rd. WPCP (Grimsby)	18.184	Conventional activated sludge, phosphorus removal - continuous	Ferrous Sulphate
Acton WPCP & Lagoon (Halton Hills)	4.546	Conventional activated sludge, phosphorus removal - batch, effluent polishing	Ferric Chloride
Georgetown WPCP (Halton Hills)	13.638	Conventional activated sludge, phosphorus removal - continuous, effluent polishing	Ferric Chloride
Woodward Ave. WPCP (Hamilton)	409.14	Conventional activated sludge	No Chemicals Used
Iroquois WPCP	5.001	Primary, phosphorus removal - continuous	Ferric Chloride
Kingston WPCP	61.371	Primary, phosphorus removal - continuous	Ferric Chloride
Kingston TWP WPCP	25.003	Conventional activated sludge, phosphorus removal - continuous	Alum
Highland Creek WPCP (Metro Toronto)	218.208	Conventional activated sludge, phosphorus removal - continuous	Ferrous Chloride
Humber WPCP (Metro Toronto)	409.140	Conventional activated sludge, phosphorus removal - continuous	Ferrous Chloride
Main WPCP (Metro Toronto)	818.28	Conventional activated sludge, phosphorus removal - continuous	Ferrous Chloride
North Toronto WPCP (Metro Toronto)	45.460	Conventional activated sludge, phosphorus removal - continuous	Ferrous Chloride
Milton WPCP	12.911	Conventional activated sludge, phosphorus removal - continuous, effluent polishing	Alum
Clarkson WPCP (Mississauga)	109.104	Conventional activated sludge, phosphorus removal - continuous	Ferrous Chloride
Lakeview WPCP (Mississauga)	227.300	Conventional activated sludge, phosphorus removal - continuous	Ferrous Chloride
Napanee WPCP	9.092	Conventional activated sludge, phosphorus removal - continuous	Ferrous Chloride
Port Darlington WPCP (Newcastle)	4.546	Conventional activated sludge, phosphorus removal - continuous	Alum
Newmarket WPCP (up to 1984)	13.638	Conventional activated sludge, phosphorus removal - continuous, effluent polishing	-
Stamford WPCP (Niagara Falls)	58.189	Primary, phosphorus removal - continuous	Ferric Chloride
South East WPCP (Oakville)	22.730	Conventional activated sludge, phosphorus removal - continuous	Alum
South West WPCP (Oakville)	47.733	Conventional activated sludge, phosphorus removal - continuous	Ferric Chloride
Orangeville WPCP	7.956	Conventional activated sludge, phosphorus removal - continuous, effluent polishing	Alum
Harmony Cr. WPCP No.1 (Oshawa)	34.095	Trickling filter, phosphorus removal - continuous	Alum
Harmony Cr. WPCP No.2 (Oshawa)	34.095	Conventional activated sludge, phosphorus removal - continuous	Alum
Peterborough WPCP	68.190	Conventional activated sludge, phosphorus removal - continuous	Ferrous Sulphate
York-Durham WPCP (Pickering)	181.84	Conventional activated sludge, phosphorus removal - continuous	Alum
Picton WPCP	4.546	Contact stabilization, phosphorus removal - continuous	Alum
Seaway WPCP (Port Colborne)	15.002	Conventional activated sludge, phosphorus removal - continuous	Ferric Chloride
Port Hope WPCP	9.092	High rate activated sludge, phosphorus removal - continuous	Alum
Prescott-Edwardsburgh WPCP	5.683	Primary, phosphorus removal - continuous	Ferric Chloride/Polymer
Port Dalhousie WPCP (St. Catharines)	61.371	Conventional activated sludge, phosphorus removal - continuous	Ferric Chloride
Port Weller WPCP (St. Catharines)	56.234	Conventional activated sludge, phosphorus removal - continuous	Alum
Trenton WPCP	15.911	Conventional activated sludge, phosphorus removal - continuous	Ferrous Chloride
Welland WPCP	45.460	Conventional activated sludge, phosphorus removal - continuous	Ferrous Chloride
Corbett Cr. WPCP (Whitby)	36.368	Conventional activated sludge, phosphorus removal - continuous	Alum
Pringle Cr. WPCP No.1 (Whitby)	5.683	Conventional activated sludge, phosphorus removal - continuous	Alum
Pringle Cr. WPCP No.2 (Whitby)	9.092	Conventional activated sludge, phosphorus removal - continuous	Alum

TABLE 7. PLANTS IN THE UPPER GREAT LAKES DRAINAGE BASIN - DESIGN FLOW, PLANT TYPE AND CHEMICALS USED FOR PHOSPHORUS REMOVAL

PLANT	DESIGN FLOW (10^3 m^3/d)	PLANT TYPE	CHEMICAL PRESENT PRESENTLY USED FOR PHOSPHORUS REMOVAL
Barrie WPCP	27.276	Conventional activated sludge, phosphorus removal - continuous	Alum
Bradford WPCP	6.819	Conventional activated sludge, phosphorus removal - continuous, effluent polishing	Alum, Polymer
Collingwood WPCP	24.548	Conventional activated sludge, phosphorus removal - continuous	Alum
Esten Lake WPCP (Elliot Lake)	13.002	Conventional activated sludge, phosphorus removal - continuous, effluent polishing	Alum
Plant Two (Elliot Lake) (up to 1982)	4.546	Primary	-
Goderich WPCP	9.092	Conventional activated sludge, phosphorus removal - continuous	Alum
Hanover WPCP	6.364	Conventional activated sludge, phosphorus removal - continuous	Alum
Huntsville WPCP	4.546	Conventional activated sludge, phosphorus removal - continuous	Alum
Midland WPCP	13.638	Conventional activated sludge, phosphorus removal - continuous	Ferric Chloride
North Bay WPCP	36.368	Conventional activated sludge, phosphorus removal - continuous	Ferric/Ferrous Chloride
Orillia WPCP	18.184	Conventional activated sludge, phosphorus removal - continuous	Alum
Owen Sound WPCP	24.548	Primary	Ferric Chloride
Parry Sound WPCP	6.592	Conventional activated sludge, phosphorus removal - continuous	Ferric Chloride
Port Elgin WPCP	6.455	Oxidation ditch	No Chemicals Used (installed in 1986)
Sault Ste. Marie WPCP	54.552	Primary	No Chemicals Used
Sturgeon Falls WPCP	4.546	Conventional activated sludge, phosphorus removal - continuous	Ferric/Ferrous Chloride (50/50)
Sudbury WPCP	61.371	High rate activated sludge	No Chemicals Used (installed in 1986)
Thunder Bay WPCP	109.104	Primary, phosphorus removal - continuous	Ferric Chloride
Hamner, Val-Caron, Val-Therese WPCP (Valley East)	11.365	Conventional activated sludge, phosphorus removal - continuous	Ferric/Ferrous Chloride
Mikkola WPCP (Walden)	4.546	Extended aeration	No Chemicals Used
Walkerton WPCP	7.546	Conventional activated sludge, phosphorus removal - continuous	Ferric Chloride
Wasaga Beach WPCP	5.773	Extended aeration, effluent polishing, exfiltration	No Chemicals Used

FIGURE 5 — GEOGRAPHIC DISTRIBUTION ONTARIO WATER POLLUTION CONTROL PLANTS IN THE GREAT LAKES DRAINAGE BASIN WITH CAPACITY > 4546 m^3/d (1 mgd)

TABLE 8. SUMMARY OF PLANT PERFORMANCE - LAKE ERIE

PLANT	DESIGN FLOW (10^3 m^3/d)	1981				1982				1983				1984				1985				LONG TERM AVERAGE (1981-1985)			
		Q	BOD	TSS	TP	Q	BOD	TSS	TP	Q	BOD	TSS	TP	Q	BOD	TSS	TP	Q	BOD	TSS	TP	Q	BOD	TSS	TP
Amherstburg WPCP P	4.546	5.5	70.9	32.0	1.8	5.0	36.1	35.8	2.19	5.0	33.6	25.3	2.90	-	43.9	26.9	4.20	-	25.2	23.9	3.25	5.1	42.7	29.0	2.82
Brantford WPCP	81.828	43.4	15.0	7.6	0.94	49.1	12.4	7.3	0.73	49.3	11.5	5.9	0.75	54.1	12.8	7.4	0.74	58.5	9.5	8.1	0.75	50.9	12.3	7.3	0.78
Galt WPCP (Cambridge)	36.641	29.4	9.1	9.6	0.82	32.1	9.3	10.4	0.76	32.8	20.2	21.3	1.02	31.5	14.1	14.1	0.89	32.0	11.3	11.6	0.80	31.6	12.8	13.4	0.86
Hespeler WPCP (Cambridge)	9.319	5.5	38.0	19.2	0.93	5.3	23.8	14.2	0.71	5.2	23.5	13.9	0.90	5.4	30.7	27.8	0.92	5.5	28.4	30.9	1.27	5.4	28.9	21.2	0.95
Preston WPCP (Cambridge)	16.866	7.7	9.1	9.1	0.76	7.8	11.9	9.0	0.76	8.0	15.4	13.5	0.72	8.0	26.5	15.1	0.57	8.5	17.5	17.2	0.77	8.0	16.1	12.8	0.72
Chatham WPCP	35.913	26.4	8.6	11.0	0.77	23.6	9.0	10.0	0.90	25.2	6.0	12.6	0.70	25.8	5.1	9.5	0.78	29.8	8.3	17.5	1.02	26.2	7.4	12.1	0.83
Dresden WPCP	4.546	1.0	6.8	19.4	0.51	1.2	4.6	10.5	0.40	1.7	3.4	10.7	0.27	2.2	4.7	8.2	0.55	2.4	3.9	8.4	0.33	1.7	4.7	11.5	0.41
Dunnville WPCP	7.728	4.0	33.1	18.9	0.64	4.5	12.6	11.2	0.58	4.5	5.7	8.2	0.50	4.6	25.2	15.7	1.02	4.9	11.9	8.4	0.62	4.5	17.7	12.5	0.67
Fergus WPCP	5.001	3.0	6.9	13.0	0.69	3.3	7.0	15.9	0.64	3.2	9.5	16.6	0.64	3.2	9.5	16.6	0.64	3.9	10.2	24.5	0.55	3.4	8.9	17.4	0.63
Guelph WPCP	54.552	43.3	18.0	16.0	1.20	44.3	24.4	14.5	1.55	44.3	14.0	10.4	1.55	43.6	15.6	11.1	0.96	47.7	7.5	7.7	0.83	44.5	15.9	11.9	1.22
Ingersoll New WPCP	6.819	3.8	9.1	7.6	1.27	4.1	7.1	10.3	1.61	4.0	3.6	6.4	0.33	5.3	8.5	6.6	0.52	4.4	6.9	6.8	0.87	4.3	7.0	7.5	0.91
Kitchener WPCP	122.742	62.3	9.5	9.3	0.80	63.0	6.4	6.9	0.84	66.0	5.6	8.3	0.87	68.6	5.4	6.3	0.69	64.5	7.4	5.2	0.76	64.9	6.9	7.2	0.79
Leamington WPCP	19.093	7.8	16.9	7.9	1.00	7.6	14.8	13.2	0.76	7.2	14.3	11.2	1.00	6.7	7.9	15.7	0.58	6.8	10.9	14.1	0.99	7.2	13.1	12.3	0.87
Adelaide WPCP (London)	18.184	13.6	3.6	4.7	1.00	15.1	3.9	5.2	0.94	14.9	2.4	5.3	0.97	16.8	2.9	5.3	0.93	17.1	2.5	5.3	0.87	15.5	3.1	5.2	0.94
Greenway WPCP (London)	123.33	103.7	4.1	7.4	1.03	123.7	4.0	7.3	1.19	122.4	3.5	6.9	0.99	127.7	4.9	9.3	0.93	132.0	5.2	9.6	0.77	121.9	4.3	8.1	0.98
Oxford WPCP (London)	5.455	3.9	6.9	16.1	2.18	4.7	7.9	16.2	1.68	4.9	5.3	11.6	0.98	5.3	5.4	11.4	0.88	5.4	4.6	7.8	0.74	4.8	6.0	12.6	1.29
Pottersburg WPCP (London)	22.048	13.5	3.4	5.4	0.73	17.3	4.0	5.1	0.70	17.9	2.6	4.8	0.96	17.4	2.9	4.2	0.85	17.4	2.8	3.9	0.63	16.7	3.1	4.6	0.77
Vauxhall WPCP (London)	20.912	19.5	3.6	7.2	0.90	20.2	4.3	6.8	0.85	18.6	3.8	8.8	0.97	18.6	4.8	9.9	0.79	19.6	3.8	8.3	0.63	19.3	4.1	8.2	0.83
Belle River-Maidstone WPCP	6.819	3.8	9.0	10.9	0.40	4.7	8.8	12.2	0.36	5.4	8.0	11.9	0.40	5.0	6.6	11.1	0.62	6.4	4.9	11.0	0.85	5.0	7.5	11.4	0.52
Corunna P.V. Plant (Moore)	4.546	2.1	4.5	11.5	0.93	2.0	5.8	9.2	0.61	1.9	4.5	10.5	0.98	1.4	7.5	8.8	0.87	2.9	9.1	9.6	0.85	2.1	6.4	9.9	0.85
Paris WPCP	7.046	2.1	18.1	27.5	1.86	2.6	22.6	20.4	-	1.9	6.0	9.1	0.90	2.2	8.7	9.5	0.58	2.5	6.2	6.7	0.55	2.3	11.3	14.4	0.93
Sarnia WPCP P	65.917	47.8	41.0	20.0	1.00	47.7	37.0	21.0	1.0	52.3	43.0	18.0	0.88	55.2	44.7	18.8	0.78	54.4	42.6	24.9	0.82	51.5	41.5	20.5	0.90
Simcoe WPCP	15.546	8.4	6.2	3.7	0.36	9.4	6.1	4.2	0.53	9.7	3.2	3.7	0.52	9.4	18.6	15.5	0.79	9.5	3.5	3.4	0.71	9.3	7.6	6.1	0.58
St. Thomas WPCP	40.914	-	9.0	82.6	1.34	15.5	4.8	6.5	1.25	18.3	4.5	4.0	0.81	18.5	11.3	10.9	1.20	18.9	6.4	8.3	1.14	21.8	7.1	22.7	1.15
Stratford WPCP	27.276	23.5	6.8	4.9	0.51	24.7	10.2	4.9	0.60	22.5	11.2	2.9	0.43	22.2	15.6	2.5	0.56	25.0	13.1	1.0	0.23	23.6	11.4	3.3	0.47
Tillsonburg WPCP	8.183	4.7	4.3	7.5	0.60	5.3	2.4	6.4	0.52	5.5	2.7	7.7	0.74	5.3	2.5	6.0	0.40	5.4	3.5	7.6	0.80	5.2	3.1	7.0	0.61
Wallaceburg WPCP	6.819	6.2	6.4	8.4	1.17	5.7	5.2	8.9	0.90	6.1	3.6	5.2	0.33	5.5	8.0	7.1	0.67	8.9	12.2	8.9	0.42	6.5	7.1	7.7	0.72
Waterloo WPCP	45.46	34.9	9.3	7.5	0.73	35.0	11.0	10.9	0.79	39.7	14.2	9.0	0.78	41.6	12.8	10.4	0.98	45.2	6.8	8.9	0.75	39.3	10.8	9.4	0.81
Little R. WPCP (Windsor)	36.368	30.9	3.6	6.6	0.39	30.8	3.4	6.8	0.41	32.3	3.0	8.0	0.43	31.6	4.8	9.9	1.22	45.0	5.3	9.5	0.83	34.1	4.0	8.2	0.65
Westerly WPCP (Windsor) P	163.656	104.1	28.8	24.0	0.92	105.5	26.0	21.6	0.79	105.0	25.0	24.0	0.89	100.7	24.6	20.6	0.73	124.7	22.2	20.0	0.86	108.0	25.3	22.0	0.84
Woodstock WPCP	36.368	19.8	6.0	8.0	0.60	21.5	5.9	16.6	1.03	22.6	8.1	16.1	0.92	21.2	9.5	20.2	0.95	23.9	11.8	16.5	1.02	21.8	8.3	15.5	0.90

P - Primary Plant

TABLE 9. SUMMARY OF PLANT PERFORMANCE - LAKE ONTARIO/ST. LAWRENCE

PLANT	DESIGN FLOW (10^3 m^3/d)	1981 Q	1981 BOD	1981 TSS	1981 TP	1982 Q	1982 BOD	1982 TSS	1982 TP	1983 Q	1983 BOD	1983 TSS	1983 TP	1984 Q	1984 BOD	1984 TSS	1984 TP	1985 Q	1985 BOD	1985 TSS	1985 TP	LONG TERM AVERAGE (1981-1985) Q	BOD	TSS	TP
Belleville WPCP	29.454	27.3	16.9	16.2	1.38	28.6	19.6	14.0	1.51	29.5	14.1	16.8	1.09	46.2	34.3	24.5	1.02	40.0	22.5	12.7	0.48	34.3	21.5	16.8	1.09
Brockville WPCP P	25.571	16.0	21.6	19.2	1.63	15.4	22.4	22.0	1.41	15.7	16.2	15.4	1.37	14.7	25.6	21.3	1.01	17.5	22.0	20.9	0.87	15.9	21.5	19.8	1.26
Burlington WPCP	93.193	75.1	7.2	10.1	1.09	77.0	8.0	8.4	0.93	86.6	7.7	6.4	0.54	87.7	9.1	7.1	0.72	67.0	9.3	7.5	0.74	78.3	8.3	7.9	0.80
Caledon WPCP	4.546	3.1	4.1	5.0	0.49	3.8	5.9	4.8	0.28	3.5	3.1	3.5	0.18	3.5	4.9	3.9	0.55	4.1	2.9	4.2	0.47	3.6	4.2	4.3	0.38
Campbellford WPCP X	5.910	6.7	5.3	7.3	0.74	7.4	4.2	6.3	0.63	7.0	4.2	4.8	0.70	7.1	5.5	4.7	0.69	6.8	6.4	5.5	0.86	7.0	5.1	5.7	0.72
Cobourg WPCP No.1 X	16.047	13.8	10.6	10.6	0.75	14.7	9.7	7.6	1.22	14.2	5.0	9.3	0.81	13.0	10.7	11.5	0.66	8.5	14.7	10.9	1.54	13.0	10.1	10.0	0.98
Cornwall WPCP P	37.505	48.6	37.5	52.6	1.67	47.5	47.4	46.9	1.58	49.2	39.2	28.5	0.99	48.5	45.6	23.7	0.98	47.7	40.4	24.5	0.99	48.3	42.0	35.2	1.24
Dundas WPCP	18.184	8.1	5.2	6.1	0.46	9.6	4.9	6.6	0.92	11.8	4.0	3.1	0.60	12.8	8.0	7.6	0.78	13.4	6.6	8.8	0.77	11.1	5.7	6.4	0.71
Anger Ave. WPCP (Fort Erie) P	16.366	17.2	36.0	27.0	0.91	16.9	54.0	22.0	1.05	13.1	25.4	20.0	0.85	12.9	27.7	23.2	0.77	13.0	34.9	28.2	0.75	14.6	35.9	24.1	0.87
Baker Rd. WPCP (Grimsby)	18.184	8.9	11.4	8.4	0.49	10.5	7.0	8.0	2.70	10.7	6.0	5.2	0.86	10.8	6.4	6.9	0.72	13.0	11.7	7.2	0.60	10.6	8.5	7.1	0.69
Acton WPCP & Lagoon (Halton Hills)	4.546	2.6	2.9	8.2	0.97	2.4	2.5	4.3	1.00	2.6	2.3	3.9	0.89	3.4	4.6	4.9	0.55	3.9	2.4	5.7	0.57	3.0	2.9	5.4	0.80
Georgetown WPCP (Halton Hills)	13.638	10.6	3.6	5.0	0.82	9.2	5.5	2.9	0.49	9.3	6.5	4.9	0.66	10.0	13.9	6.0	1.16	11.2	3.6	3.2	0.49	10.0	6.6	4.4	0.73
Woodward Ave. WPCP (Hamilton) X	409.14	264.1	17.4	31.6	2.24	290.0	11.2	17.0	1.15	287.8	15.0	13.0	1.10	323.5	17.9	19.4	1.27	308.3	23.4	19.7	1.31	294.7	17.3	20.1	1.41
Iroquois WPCP P	5.001	3.5	38.0	22.0	3.10	3.5	85.0	54.0	3.00	3.5	93.0	74.0	2.30	3.2	111.9	83.5	2.15	4.1	80.0	79.0	1.90	3.6	80.0	56.7	2.68
Kingston WPCP P	61.371	53.6	22.0	35.0	1.20	60.0	23.0	31.0	1.10	60.1	29.8	25.9	0.91	57.3	25.0	37.1	0.96	66.4	23.7	19.8	0.78	58.7	24.8	30.9	1.01
Kingston TWP WPCP	25.003	16.0	12.5	13.0	1.07	16.6	9.4	7.9	0.92	16.3	11.3	8.6	0.92	15.6	10.9	9.1	0.91	16.4	10.8	8.6	0.89	16.1	11.0	9.5	0.94
Highland Creek WPCP (Metro Toronto)	218.21	153.2	22.6	16.8	1.00	162.3	18.1	11.8	1.04	162.8	19.8	18.0	1.05	156.9	33.9	24.5	0.91	163.3	18.8	16.5	0.77	159.7	22.7	17.5	0.95
Humber WPCP (Metro Toronto)	409.14	406.0	16.4	24.2	1.50	368.7	14.8	18.7	1.24	365.5	14.1	22.5	1.04	339.6	12.7	26.3	1.43	378.1	11.5	18.2	1.08	371.6	13.9	22.0	1.26
Main WPCP (Metro Toronto)	818.28	752.4	17.1	11.7	0.80	709.2	11.6	13.9	0.91	737.6	13.2	11.8	0.89	677.3	19.3	11.9	0.97	683.8	22.3	26.0	1.09	712.0	14.7	15.1	0.93
North Toronto WPCP (Metro Toronto)	45.460	36.4	15.9	20.9	1.00	36.2	18.5	21.8	1.08	35.4	14.5	17.1	1.01	35.8	12.8	7.7	0.85	34.7	15.1	6.8	0.85	35.7	15.4	14.8	0.96
Milton WPCP	12.911	9.5	4.3	5.4	0.50	9.0	4.6	3.3	0.43	9.6	3.7	3.6	0.57	9.9	8.1	2.9	0.36	12.3	2.5	2.6	0.29	10.1	4.6	3.6	0.44
Clarkson WPCP (Mississauga)	109.104	48.1	5.9	10.8	0.81	59.2	7.6	8.7	1.02	67.1	9.1	8.7	1.08	75.3	8.2	8.2	0.89	71.2	11.6	9.5	0.90	64.2	8.5	9.2	0.94
Lakeview WPCP (Mississauga)	227.30	179.0	16.5	15.0	0.78	194.6	19.7	17.2	0.70	190.1	16.1	19.8	0.89	198.8	18.7	18.9	0.85	230.5	16.5	15.7	0.65	198.7	17.5	17.3	0.77
Napanee WPCP	9.092	5.9	30.2	63.5	4.9	6.0	48.4	63.0	8.20	5.4	10.0	19.4	2.20	6.1	7.8	11.8	2.46	7.4	5.8	10.3	1.41	6.2	20.4	33.6	3.83
Port Darlington WPCP (Newcastle)	4.546	-	-	-	-	5.2	18.1	24.1	1.45	6.7	13.5	17.4	1.50	6.4	24.4	17.1	1.83	8.1	13.4	14.1	0.93	6.6	17.2	18.3	1.42
Newmarket WPCP	13.638	13.4	12.8	7.2	0.97	16.5	14.8	5.2	0.63	15.1	10.6	5.6	0.80	14.7	-	-	-	-	-	-	-	14.9	12.7	6.0	0.80
Stamford WPCP (Niagara Falls) P	58.189	44.6	27.0	26.0	1.00	51.9	42.0	26.0	0.80	56.2	50.0	22.0	1.00	56.2	38.0	29.7	0.63	57.1	31.3	23.8	0.46	53.2	37.7	25.5	0.78
South East WPCP (Oakville)	22.730	12.1	2.2	7.1	0.84	11.8	2.7	9.1	0.75	12.4	2.4	5.8	0.96	12.5	3.9	7.3	0.87	-	2.6	8.2	0.86	-	2.8	7.5	0.86
South West WPCP (Oakville)	47.733	30.6	11.8	14.0	1.10	30.0	16.7	14.2	1.37	28.2	10.2	16.3	1.53	24.8	12.3	13.4	0.93	29.0	7.2	15.1	0.91	28.5	11.7	14.6	1.17
Orangeville WPCP	7.956	7.1	4.0	4.9	0.46	8.1	3.1	5.4	0.48	7.4	2.6	3.0	0.31	7.3	6.3	5.3	0.36	8.1	2.5	3.6	0.26	7.6	3.7	4.4	0.37
Harmony Cr. WPCP No.1 (Oshawa)	34.095	25.6	25.0	21.0	1.30	30.9	15.1	16.7	0.90	26.4	*14.4	*18.7	0.89*	25.9	12.8*	18.0*	1.02*	27.1	19.1	17.0*	0.61*	27.2	17.4	18.3	0.94
Harmony Cr. WPCP No.2 (Oshawa)	34.095	27.7	9.5	10.0	0.51	29.6	17.4	14.9	0.87	25.9	*14.4	*18.7	0.89*	26.7	12.8*	18.0*	1.02*	27.2	19.1*	17.0*	0.61*	27.4	14.6	15.6	0.78
Peterborough WPCP	68.190	51.9	8.2	8.6	0.74	54.4	11.7	10.0	0.94	53.1	9.2	7.0	0.77	54.6	12.2	6.0	0.81	56.9	11.9	7.1	0.80	54.1	10.6	7.8	0.81
York-Durham WPCP (Pickering)	181.84	41.4	14.9	18.0	0.98	84.5	14.1	12.2	1.75	95.1	22.5	25.2	1.73	121.1	12.8	15.9	0.98	150.0	14.3	15.6	1.05	98.4	15.7	17.4	1.30
Picton WPCP	4.546	3.6	10.4	16.3	1.30	3.6	7.1	13.2	0.75	3.3	7.2	9.3	0.52	3.2	7.3	9.4	0.68	3.1	5.7	8.5	0.50	3.4	7.6	11.4	0.75
Seaway WPCP (Port Colborne)	15.002	11.1	10.4	12.0	0.68	12.9	7.0	15.0	0.70	13.9	11.9	9.7	0.89	14.1	13.2	15.8	1.15	13.2	13.1	15.8	1.13	13.0	11.1	13.7	0.91
Port Hope WPCP	9.092	8.2	4.1	7.0	0.55	6.6	4.0	6.3	1.00	7.4	8.0	4.5	0.57	8.4	5.4	5.7	0.53	9.6	6.0	5.4	0.56	8.0	5.5	5.8	0.64
Prescott-Edwardsburgh WPCP P	5.683	4.7	14.4	26.9	0.67	4.4	17.9	29.8	0.79	4.6	19.8	30.8	0.84	4.5	21.3	31.1	0.88	5.2	17.2	20.3	0.61	4.7	18.1	27.8	0.76
Port Dalhousie WPCP (St. Catharines)	61.371	35.5	9.2	9.9	0.58	36.8	7.0	7.0	0.70	36.4	4.0	6.9	0.53	32.4	7.7	7.5	0.55	41.6	11.5	10.6	0.39	36.5	7.9	8.4	0.55
Port Weller WPCP (St. Catharines)	56.234	38.1	14.7	10.0	0.57	35.6	42.0	26.0	0.80	35.8	9.9	11.8	0.74	35.9	11.9	13.7	0.57	42.1	12.0	13.2	0.78	37.5	18.1	15.0	0.69
Trenton WPCP	15.911	10.9	9.0	7.9	0.71	9.6	15.1	13.0	1.14	9.8	14.1	12.9	0.82	10.8	13.8	11.6	0.58	11.2	10.8	13.0	0.67	10.5	12.6	11.7	0.78
Welland WPCP	45.45	36.9	7.9	10.2	0.71	38.1	11.0	12.0	1.10	41.9	11.1	10.3	0.55	33.9	9.6	10.8	0.73	35.8	11.6	12.1	0.76	35.6	11.5	11.4	0.70
Corbett Cr. WPCP (Whitby)	36.368	15.3	18.2	30.2	2.0	14.9	18.6	39.3	1.70	10.9	13.1	11.5	0.76	10.9	25.0	19.8	0.85	13.5	10.0	13.1	0.59	13.1	16.7	22.8	1.18
Pringle Cr. WPCP No.1 (Whitby)	5.683	4.4	4.0	6.0	0.54	4.3	13.8	12.6	0.62	4.3	5.8	9.8	0.38	6.0	20.2	14.4	0.90	5.5	19.3	14.5	0.70	4.9	12.6	11.5	0.63
Pringle Cr. WPCP No.2 (Whitby)	9.092	6.2	4.2	6.0	0.69	6.1	17.3	27.1	1.27	6.8	6.2	6.5	0.69	6.3	23.1	18.9	1.09	6.5	19.5	14.5	0.94	6.4	14.1	14.6	0.93

P - Primary Plant
X - No Chemicals Used for P Removal
* Combined Effluents

TABLE 10. SUMMARY OF PLANT PERFORMANCE - UPPER GREAT LAKES

PLANT		DESIGN FLOW (10^3 m^3/d)	1981				1982				1983				1984				1985				LONG TERM AVERAGE (1981-1985)			
			Q	BOD	TSS	TP	Q	BOD	TSS	TP	Q	BOD	TSS	TP	Q	BOD	TSS	TP	Q	BOD	TSS	TP	Q	BOD	TSS	TP
Barrie WPCP		27.276	22.8	10.6	19.1	1.06	21.8	53.0	18.0	0.96	22.7	10.5	16.4	0.9	26.5	8.4	17.7	0.97	26.1	6.8	12.6	0.50	24.0	17.9	16.8	0.89
Bradford WPCP		6.819	3.0	20.3	19.6	0.76	3.4	14.7	12.8	0.42	3.1	6.6	8.7	0.4	3.4	3.0	2.9	0.77	3.1	6.5	6.4	0.42	3.2	10.3	9.9	0.55
Collingwood WPCP		24.548	15.9	70.0	42.0	1.85	15.3	15.0	15.0	0.60	17.1	8.0	10.2	1.7	17.4	7.9	15.3	1.49	18.5	5.8	12.6	1.92	16.8	22.3	19.1	1.50
Esten Lake WPCP (Elliot Lake)		13.002	-	-	-	-	9.7	13.8	11.6	0.77	8.5	12.5	9.8	0.7	10.9	7.9	12.0	1.33	12.5	15.3	15.9	1.10	10.4	12.6	12.4	0.97
Plant Two (Elliot Lake)	P	4.546	4.5	4.3	65.0	5.3	--	--	--	--	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Goderich WPCP P (until 1983)		9.092	8.5	10.0	5.0	2.0	7.7	13.0	5.3	2.0	7.1	8.0	7.2	1.5	9.6	6.2	10.0	1.10	11.2	5.5	10.6	0.87	8.8	8.7	7.9	1.49
Hanover WPCP		6.364	3.3	19.4	10.5	2.1	3.7	12.0	13.3	1.0	3.7	8.5	7.5	0.6	3.7	6.9	6.3	0.86	4.3	9.4	7.5	0.87	3.7	11.2	9.2	1.09
Huntsville WPCP		4.546	3.0	6.4	7.6	0.50	4.0	6.3	9.5	0.45	4.0	11.3	13.3	0.4	4.5	6.1	6.7	0.31	4.8	4.4	13.7	0.76	4.0	7.0	9.9	0.45
Midland WPCP		13.638	8.7	33.2	36.9	11.74	8.4	7.2	4.2	0.46	9.0	8.7	7.3	0.3	9.2	13.9	7.4	0.56	10.9	3.0	6.4	0.57	9.3	13.4	12.6	2.85
North Bay WPCP		36.368	33.3	15.5	19.9	1.38	31.3	22.3	24.1	1.28	32.3	24.5	23.7	1.2	32.6	17.4	24.2	1.50	40.1	22.1	31.4	1.68	33.9	20.5	25.7	1.42
Orillia WPCP		18.184	15.2	12.0	13.8	0.48	17.4	19.0	20.0	0.30	17.5	17.3	8.1	0.3	18.4	18.5	14.8	0.41	19.2	18.4	19.8	0.58	17.6	17.0	15.2	0.41
Owen Sound WPCP	P	24.548	18.1	27.7	26.1	0.82	22.8	24.5	19.8	1.01	19.6	28.8	23.8	1.3	19.6	25.7	25.2	0.84	22.5	23.8	20.4	0.85	20.5	26.1	23.1	0.95
Parry Sound WPCP		6.592	5.2	24.3	38.6	1.14	4.4	6.7	9.3	0.85	4.2	5.2	9.7	0.9	3.4	3.4	8.7	0.86	3.9	6.6	5.7	0.56	4.2	9.3	14.8	0.86
Port Elgin WPCP	X	6.455	3.6	5.4	3.6	2.13	3.5	4.7	2.7	2.4	3.6	2.8	3.6	1.6	3.4	4.0	3.0	1.93	4.1	8.8	2.7	1.56	3.7	5.2	3.1	1.91
Sault Ste. Marie WPCP	XP	54.552	48.3	69.5	54.8	3.15	51.1	67.8	54.6	3.08	46.9	74.1	55.3	4.1	45.9	83.1	61.8	4.61	50.3	83.2	60.0	4.23	48.5	76.4	56.8	3.86
Sturgeon Falls WPCP		4.546	6.7	7.1	6.2	0.70	6.4	5.2	4.8	0.65	6.9	4.8	6.6	0.5	6.8	6.0	5.3	0.33	5.6	4.6	6.0	0.46	6.5	5.6	5.8	0.52
Sudbury WPCP	X	61.371	52.1	11.6	12.7	2.20	51.2	17.3	10.0	1.90	54.9	16.6	13.1	1.5	54.9	10.0	9.4	1.84	52.0	11.9	8.3	2.10	53.0	13.5	10.7	1.91
Thunder Bay WPCP	P	109.104	81.7	53.1	53.6	3.14	96.8	69.6	76.1	3.10	100.5	47.2	43.2	1.6	104.2	51.7	36.1	1.27	113.8	51.4	33.7	1.01	99.4	55.1	48.5	2.03
Hamner, Val-Caron, Val-Therese WPCP (Valley East)		11.365	4.1	15.4	7.1	1.40	4.4	18.1	8.9	1.70	4.8	14.3	4.0	1.5	5.1	14.3	2.8	1.14	5.6	14.3	5.1	0.69	4.8	15.3	5.6	1.29
Mikkola WPCP (Walden)	X	4.546	-	-	-	-	0.5	6.1	20.7	1.7	0.9	11.7	54.5	2.6	1.2	6.2	9.9	2.34	1.2	3.8	4.3	2.66	0.9	7.0	20.1	2.33
Walkerton WPCP		7.546	4.4	19.2	13.7	2.72	5.8	12.9	13.0	0.93	4.9	16.0	13.7	1.3	5.1	16.0	11.7	0.99	5.9	14.0	9.6	0.90	5.2	15.6	12.2	1.38
Wasaga Beach WPCP	X	5.773	-	-	-	-	0.4	--	--	--	0.7	-	-	-	0.8	-	-	-	1.0	-	-	-	0.7	-	-	-

P - Primary Plant
X - No Chemicals Used for P Removal

Effluent requirements that were used were based on MOE Effluent Criteria for BOD_5, TSS and TP (Policy 0801, revised in 1983), as presented in Table 11. For primary plants, the exceedance of Effluent Design Objectives indicated non-compliance. For secondary plants, the exceedance of the Effluent Guidelines indicated non-compliance. For all plants, including those not practicing phosphorus removal, the phosphorus effluent requirement was considered to be 1 mg/L. Although the performance data from all plants was analyzed using the above guidelines, it should be noted that several plants have more stringent site-specific requirements with respect to BOD_5, TSS and/or TP, as shown in Table 12.

Tables 13 to 15 present the annual compliance history (compliance with annual average effluent requirement) for the individual treatment facilities for the years 1981 to 1985 with respect to BOD_5, TSS and TP. In the Lake Erie Basin, seventeen plants (54.8 percent of the 31 plants evaluated) were in compliance on an annual basis with all effluent requirements (BOD_5, TSS and TP) for every year (1981 to 1985). In the Lake Ontario/St. Lawrence River Basin, fifteen plants (34.0 percent of the 44 plants evaluated) were in compliance with all requirements every year and in the Upper Great Lakes Basin, 3 plants (14.3 percent of 21 plants) were in compliance with all requirements every year. Overall, 35 plants (36.4 percent of 96 plants) met all requirements every year during 1981 to 1985.

In Figure 6, a histogram presents the number of plants that were not in compliance with respect to annual average BOD_5, TSS and TP effluent concentrations for the 5 year period. These data indicated a decreasing trend in the number of plants that were not in compliance from 1981 to 1985 for all parameters. It should also be noted that there were a significantly greater number of plants that exceeded TP effluent limits compared to those that exceeded BOD_5 and TSS effluent limits.

Tables 16 to 18 summarize the compliance status for BOD_5, TSS and TP of these plants for the years 1984 and 1985 when compliance is assessed on a monthly basis, along with their compliance status on the basis of annual average effluent concentration. It should again be noted that plants were not attempting to meet a monthly compliance requirement during these years. From these data, summaries presenting the number of plants that were in compliance on an annual average basis compared to the number of plants that would be in compliance on a monthly average basis were developed and are presented in Table 19 and Figures 7 to 9. It can be observed that there are

TABLE 11. MOE EFFLUENT CRITERIA (POLICY 0801, 1983)

TREATMENT LEVEL & PROCESS	EFFLUENT DESIGN OBJECTIVES			EFFLUENT GUIDELINES	
	BOD_5	TSS	TP	BOD_5	TSS
A. Primary Treatment					
- Without P-removal	30% Removal	50% Removal			
- With P-removal	50% Removal	70% Removal	- 1.0		
B. Secondary Treatment					
- Conventional A.S.	15	15	1.0	25	25
- Contact Stabilization	20	20	1.0	25	25
- Extended Aeration	15	15	1.0	25	25

TABLE 12. MUNICIPAL WASTEWATER TREATMENT FACILITIES IN THE GREAT LAKES BASIN WITH SITE-SPECIFIC EFFLUENT QUALITY GUIDELINES

PLANT	BOD_5		TSS		TP	
	mg/L	kg/d	mg/L	kg/d	mg/L	kg/d
Lake Erie						
Chatham WPCP	15		15			
Guelph WPCP		440			0.5[1]	
Stratford WPCP					0.5[2]	
Lake Ontario/St. Lawrence						
Belleville WPCP					0.5[2]	
Acton WPCP (Halton Hills)		13.6				
Georgetown WPCP (Halton Hills)		136				
Milton WPCP	4.2		15.0		0.43[3]	
Orangeville WPCP	7.5	60	7.5	60	0.5	4.0
Picton WPCP					0.5[2]	
Trenton WPCP					0.5[2]	
Upper Great Lakes						
Bradford WPCP					0.3	
Goderich WPCP	15	136	15	136		0.9
Hanover WPCP	15		15			

1. River Temp $\leq$ 10°C, TP $\leq$ 1.0 mg/L, >10°C, TP $\leq$ 0.5 mg/L
2. May to October
3. Soluble P

TABLE 13. SUMMARY OF ANNUAL AND LONG-TERM COMPLIANCE FOR BOD, TSS, TP (1981-1985) FOR THE LAKE ERIE DRAINAGE BASIN

PLANT		1981			1982			1983			1984			1985			LONG TERM AVERAGE (1981-1985)		
		BOD	TSS	TP	BOD	TSS	TP	BOD	TSS	TP	BOD	TSS	TP	BOD	TSS	TP	BOD	TSS	TP
Amherstburg WPCP	P	N	N	N	N	N	N	N	N	N	N	N	N	.	.	N	N	N	N
Brantford WPCP		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Galt WPCP (Cambridge)		.	.	.	.	.	.	.	.	N	.	.	.	.	.	.	.	.	.
Hespeler WPCP (Cambridge)		N	.	.	.	.	.	.	.	.	N	N	.	N	N	.	N	.	.
Preston (Cambridge)		.	.	.	.	.	.	.	.	.	N	.	.	.	.	.	.	.	.
Chatham WPCP		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dresden WPCP		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dunnville WPCP		N	.	.	.	.	.	.	.	.	N	.	N	.	.	.	.	.	.
Fergus WPCP		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Guelph WPCP		.	.	N	.	.	N	.	.	N	.	.	.	.	.	.	.	.	N
Ingersoll New WPCP		.	.	N	.	.	N	.	.	.	.	.	.	.	.	.	.	.	.
Kitchener WPCP		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leamington WPCP		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Adelaide WPCP (London)		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Greenway WPCP (London)		.	.	N	.	.	N	.	.	.	.	.	.	.	.	.	.	.	.
Oxford WPCP (London)		.	.	N	.	.	N	.	.	.	.	.	.	.	.	.	.	.	N
Pottersburg WPCP (London)		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vauxhall WPCP (London)		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Belle River-Maidstone WPCP		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Corunna P.V. Plant (Moore)		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Paris WPCP		.	N	N	.	.	–	.	.	.	.	.	.	.	.	.	.	.	.
Sarnia WPCP	P	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Simcoe WPCP		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
St. Thomas WPCP		.	N	N	.	.	N	.	.	.	.	.	N	.	.	N	.	.	N
Stratford WPCP		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tillsonburg WPCP		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Wallaceburg WPCP		.	.	N	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Waterloo WPCP		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Little R. WPCP (Windsor)		.	.	.	.	.	.	.	.	.	.	.	N	.	.	.	.	.	.
Westerly WPCP (Windsor)	P	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Woodstock WPCP		.	.	.	.	.	N	.	.	.	.	.	.	.	.	N	.	.	.

P - Primary Plant
X - No Chemicals Used for P Removal
N - Not in Compliance
. - In Compliance

* Compliance Based on MOE 1983 Effluent Criteria (Table 11).

TABLE 14. SUMMARY OF ANNUAL AND LONG-TERM COMPLIANCE FOR BOD, TSS, TP (1981-1985) FOR THE LAKE ONTARIO/ST. LAWRENCE DRAINAGE BASIN

PLANT		1981			1982			1983			1984			1985			LONG TERM AVERAGE (1981-1985)		
		BOD	TSS	TP	BOD	TSS	TP	BOD	TSS	TP	BOD	TSS	TP	BOD	TSS	TP	BOD	TSS	TP
Belleville WPCP		.	.	N	.	.	N	.	.	N	N	.	N	.	.	.	.	.	N
Brockville WPCP	P	.	.	N	.	.	N	.	.	N	.	.	N	.	.	.	.	.	N
Skyway WPCP (Burlington)		.	.	N	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bolton WPCP (Caledon)		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Campbellford WPCP	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cobourg WPCP No. 1	X	.	.	.	.	.	N	.	.	.	.	.	.	.	.	N	.	.	.
Cornwall WPCP	P	N	.	N	N	N	N	N	N	.	N	.	.	.	.	.	N	N	N
Dundas WPCP		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anger Ave. WPCP (Fort Erie)	P	.	N	.	N	.	N	.	.	.	.	.	.	.	.	.	.	.	.
Baker Rd. WPCP (Grimsby)		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acton WPCP & Lagoon (Halton Hills)		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Georgetown WPCP (Halton Hills)		.	.	.	.	.	.	.	.	.	.	.	N	.	.	.	.	.	.
Woodward Ave. WPCP (Hamilton)	X	.	N	N	.	.	N	.	.	N	.	.	N	.	.	N	.	.	N
Iroquois WPCP	P	.	N	N	N	N	N	N	N	N	N	N	N	-	-	-	N	N	N
Kingston WPCP	P	.	.	N	.	.	N	.	.	.	.	.	.	.	.	.	.	.	N
Kingston TWP WPCP		.	.	N	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Highland Creek WPCP (Metro Toronto)		.	.	.	.	.	N	.	.	N	N	.	.	.	.	.	.	.	.
Humber WPCP (Metro Toronto)		.	.	N	.	.	N	.	.	N	.	N	N	.	.	N	.	.	N
Main WPCP (Metro Toronto)		.	.	.	.	.	.	.	.	.	.	.	.	.	.	N	.	.	.
North Toronto WPCP (Metro Toronto)		.	.	.	.	.	N	.	.	N	.	.	.	.	.	.	.	.	.
Milton WPCP		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Clarkson WPCP (Mississauga)		.	.	.	.	.	N	.	.	N	.	.	.	.	.	.	.	.	.
Lakeview WPCP (Mississauga)		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Napanee WPCP		N	N	N	N	N	N	.	.	N	.	.	N	.	.	N	.	N	N
Port Darlington WPCP (Newcastle)		-	-	-	.	.	N	.	.	N	.	.	N	.	.	.	.	.	N
Newmarket WPCP		.	.	.	.	.	.	.	.	.	-	-	-	-	-	-	.	.	.
Stamford WPCP (Niagara Falls)	P	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
South East WPCP (Oakville)		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
South West WPCP (Oakville)		.	.	N	.	.	N	.	.	N	.	.	.	.	.	.	.	.	N
Orangeville WPCP		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Harmony Cr. WPCP No. 1 (Oshawa)		.	.	N	.	.	.	.	.	.	.	.	N	.	.	.	.	.	.
Harmony Cr. WPCP No. 2 (Oshawa)		.	.	.	.	.	.	.	.	.	.	.	N	.	.	.	.	.	.
Peterborough WPCP		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
York Durham WPCP (Pickering)		.	.	.	.	.	N	.	N	N	.	.	.	.	.	N	.	.	N
Picton WPCP		.	.	N	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Seaway WPCP (Port Colborne)		.	.	.	.	.	.	.	.	.	.	.	N	.	.	N	.	.	.
Port Hope WPCP		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Prescott-Edwardsburg WPCP	P	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Port Dalhousie WPCP (St. Catharines)		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Port Weller WPCP (St. Catharines)		.	.	.	N	N	.	.	.	.	.	.	.	.	.	.	.	.	.
Trenton WPCP		.	.	.	.	.	N	.	.	.	.	.	.	.	.	.	.	.	.
Welland WPCP		.	.	.	.	.	N	.	.	.	.	.	.	.	.	.	.	.	.
Corbett Cr. WPCP (Whitby)		.	N	N	.	N	N	.	.	.	.	.	.	.	.	.	.	.	N
Pringle Cr. WPCP No. 1 (Whitby)		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pringle Cr. WPCP No .2 (Whitby)		.	.	.	.	N	N	.	.	.	.	.	N	.	.	.	.	.	.

P - Primary Plant

X - No Chemicals Used for P Removal

N - Not in Compliance

. - In Compliance

* Compliance Based on MOE 1983 Effluent Criteria (Table 11).

TABLE 15. SUMMARY OF ANNUAL AND LONG-TERM COMPLIANCE FOR BOD, TSS, TP (1981-1985) FOR THE UPPER GREAT LAKES DRAINAGE BASIN

PLANT		1981			1982			1983			1984			1985			LONG TERM AVERAGE (1981-1985)		
		BOD	TSS	TP	BOD	TSS	TP	BOD	TSS	TP	BOD	TSS	TP	BOD	TSS	TP	BOD	TSS	TP
Barrie WPCP		.	.	N	N	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bradford WPCP		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Collingwood WPCP		N	N	N	.	.	.	.	.	N	.	.	N	.	.	N	.	.	N
Esten Lake WPCP (Elliot Lake)		-	-	-	.	.	.	.	.	.	.	.	N	.	.	N	.	.	.
Goderich WPCP	P (until 1983)	.	.	N	.	.	N	.	.	N	.	.	N	.	.	.	.	.	N
Hanover WPCP		.	.	N	.	.	.	.	.	.	.	.	.	.	.	.	.	.	N
Huntsville WPCP		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Midland WPCP		N	N	N	.	.	.	.	.	.	.	.	.	.	.	.	.	.	N
North Bay WPCP		.	.	N	.	N	N	.	N	N	.	.	N	.	.	N	.	N	N
Orillia WPCP		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Owen Sound WPCP	P	.	.	.	.	.	N	.	.	N	.	.	.	.	.	.	.	.	.
Parry Sound WPCP		.	N	N	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Port Elgin WPCP	X	.	.	N	.	.	N	.	.	N	.	.	N	.	.	N	.	.	N
Sault Ste. Marie WPCP	XP	.	.	N	.	.	N	.	.	N	.	.	N	.	.	N	.	.	N
Sturgeon Falls WPCP		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sudbury WPCP	X	.	.	N	.	.	N	.	.	N	.	.	N	.	.	N	.	.	N
Thunder Bay WPCP	P	.	.	N	.	.	N	.	.	N	.	.	N	.	.	N	.	.	N
Hamner, Val-Caron, Val-Therese WPCP (Valley East)		.	.	N	.	.	N	.	.	N	.	.	N	.	.	.	.	.	N
Mikkola WPCP (Walden)	X	-	-	-	.	.	N	.	.	N	.	.	N	.	.	N	.	.	N
Walkerton WPCP		.	.	N	.	.	.	.	.	N	.	.	.	.	.	.	.	.	N
Wasaga Beach WPCP	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

P - Primary Plant
X - No Chemicals Used for P Removal
N - Not in Compliance
. - In Compliance

* Compliance Based on MOE 1983 Effluent Criteria (Table 11).

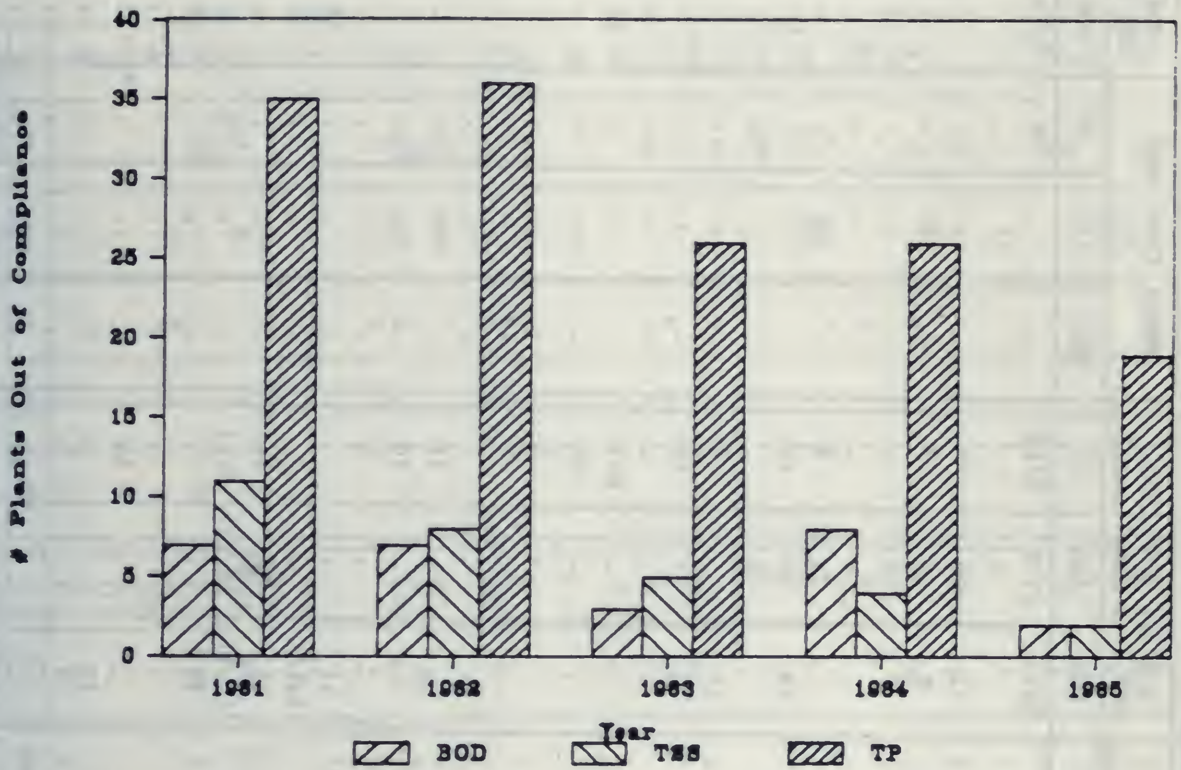

FIGURE 6 - ANNUAL COMPLIANCE SUMMARY FOR 96 PLANTS IN ONTARIO

TABLE 16. SUMMARY OF ANNUAL AND MONTHLY COMPLIANCE* FOR LAKE ERIE DRAINAGE BASIN (1984 & 1985)

PLANT	1984						1985					
	ANNUAL COMPLIANCE			MONTHLY COMPLIANCE (Mo's in Compliance)			ANNUAL COMPLIANCE			MONTHLY COMPLIANCE (Mo's in Compliance)		
	BOD	TSS	TP	BOD	TSS	TP	BOD	TSS	TP	BOD	TSS	TP
Amherstburg WPCP P	N	N	N	3/10	3/10	0/10	.	.	N	4/11	5/11	2
Brantford WPCP	.	.	.	.	.	.	.	.	.	.	.	11
Galt WPCP (Cambridge)	.	.	.	11	10	10	.	.	.	.	.	.
Hespeler WPCP (Cambridge)	N	N	.	4	6	7	N	N	.	5	5	5
Preston WPCP (Cambridge)	N	.	.	7	11	.	.	.	.	9	10	10
Chatham WPCP	.	.	.	.	.	.	.	.	.	.	10	7
Dresden WPCP	.	.	.	.	.	9	.	.	.	.	.	.
Dunnville WPCP	N	.	N	10	10	10	.	.	.	11	.	.
Fergus WPCP	.	.	.	.	9	.	.	.	.	.	7	.
Guelph WPCP	.	.	.	11	.	6	.	.	.	.	.	10
Ingersoll New WPCP	.	.	.	.	.	10	.	.	.	.	.	9
Kitchener WPCP	.	.	.	.	.	.	.	.	.	.	.	.
Leamington WPCP	.	.	.	.	.	8/10	.	.	.	11	10	8
Adelaide WPCP (London)	.	.	.	.	.	10	.	.	.	.	.	.
Greenway WPCP (London)	.	.	.	.	.	8	.	.	.	.	.	10
Oxford WPCP (London)	.	.	.	.	.	9	.	.	.	.	.	.
Pottersburg WPCP (London)	.	.	.	.	.	.	.	.	.	.	.	11
Vauxhall WPCP (London)	.	.	.	.	.	11	.	.	.	.	.	11
Belle-River - Maidstone WPCP	.	.	.	.	.	10	.	.	.	.	.	9
Corunna P.V. Plant (Moore)	.	.	.	.	.	5	.	.	.	.	.	7
Paris WPCP	.	.	.	11	.	.	.	.	.	11	.	11
Sarnia WPCP P	.	.	.	9/10	.	.	.	.	.	.	.	11
Simcoe WPCP	.	.	.	11	10	11	.	.	.	.	.	.
St. Thomas WPCP	.	.	N	10/11	10/11	5/11	.	.	N	.	11	7
Stratford WPCP	.	.	.	11	.	.	.	.	.	11	.	.
Tillsonburg WPCP	.	.	.	.	.	.	.	.	.	.	.	11
Wallaceburg WPCP	.	.	.	.	.	10	.	.	.	11	.	8/9
Waterloo WPCP	.	.	.	11	.	8	.	.	.	.	.	11
Little R. WPCP (Windsor)	.	.	N	.	.	7	.	.	.	.	.	8
Westerly WPCP (Windsor) P	.	.	.	.	.	11	.	.	.	.	.	10
Woodstock WPCP	.	.	.	.	.	10	.	.	N	.	.	6/11

P - Primary Plant
X - No Chemicals Used for P Removal

* Compliance based on MOE 1983 Effluent Criteria (Table 11).

TABLE 17. SUMMARY OF ANNUAL AND MONTHLY COMPLIANCE* FOR LAKE ONTARIO DRAINAGE BASIN (1984 & 1985)

PLANT	1984 ANNUAL COMPLIANCE BOD	1984 ANNUAL COMPLIANCE TSS	1984 ANNUAL COMPLIANCE TP	1984 MONTHLY COMPLIANCE (Mo's in Compliance) BOD	1984 MONTHLY COMPLIANCE (Mo's in Compliance) TSS	1984 MONTHLY COMPLIANCE (Mo's in Compliance) TP	1985 ANNUAL COMPLIANCE BOD	1985 ANNUAL COMPLIANCE TSS	1985 ANNUAL COMPLIANCE TP	1985 MONTHLY COMPLIANCE (Mo's in Compliance) BOD	1985 MONTHLY COMPLIANCE (Mo's in Compliance) TSS	1985 MONTHLY COMPLIANCE (Mo's in Compliance) TP
Belleville WPCP	N	.	N	8	8	8	.	.	.	8	.	.
Brockville WPCP P	.	.	N	11	.	6	.	.	.	.	.	9
Burlington WPCP	.	.	.	.	.	11	.	.	.	.	.	11
Caledon WPCP	.	.	.	.	.	.	.	.	.	.	.	9/10
Campbellford WPCP X	.	.	.	.	.	10/11	.	.	.	.	.	9
Cobourg WPCP No.1 X	.	.	.	.	.	10	.	.	N	11	.	9
Cornwall WPCP P	N	.	.	9	10	8	N	.	.	4	11	6
Dundas WPCP	.	.	.	.	.	7	.	.	.	.	11	9
Anger Ave. WPCP (Fort Erie) P	.	.	.	9/10	5/10	8/10	.	N	.	9	6	10
Baker Rd. WPCP (Grimsby)	.	.	.	.	.	10/11	.	.	.	11	.	.
Acton WPCP + Lagoon (Halton Hills)	.	.	.	.	.	10	.	.	.	.	.	11
Georgetown WPCP (Halton Hills)	.	.	N	11	.	7	.	.	.	.	.	.
Woodward Ave. WPCP (Hamilton) X	.	.	N	10	9	4	.	.	N	7	9	3
Iroquois WPCP P	N	N	N	1/9	0/9	2/8	.	N	N	0/1	0/1	0/1
Kingston WPCP P	.	.	.	9	10	8	.	.	.	.	11	10
Kingston Twp. WPCP	.	.	.	.	.	10	.	.	.	5/6	5/6	.
Highland Cr. WPCP (Metro Toronto)	N	.	.	2	7	10	.	.	.	11	11	.
Humber WPCP (Metro Toronto)	.	N	N	.	8	2	.	.	N	.	11	6
Main WPCP (Metro Toronto)	.	.	.	9	.	8	.	.	N	8	7	5
North Toronto WPCP (Metro Toronto)	.	.	.	.	.	9	.	.	.	11	.	10
Milton WPCP	.	.	.	.	.	.	.	.	.	.	.	.
Clarkson WPCP (Mississauga)	.	.	.	.	.	11	.	.	.	.	.	10
Lakeview WPCP (Mississauga)	.	.	.	.	11	10	.	.	.	.	11	.
Napanee WPCP	.	.	N	.	11	1	.	.	N	.	.	3
Port Darlington (New Castle)	.	.	N	7/10	8/10	4/10	.	.	.	.	.	7/11
Stamford WPCP (Niagara Falls) P	.	.	.	7	.	11	.	.	.	11	11	.
South East WPCP (Oakville)	.	.	.	.	.	8	.	.	.	.	.	8/11
South East WPCP (Oakville)	.	.	.	.	.	8	.	.	.	.	10/11	8/11
Orangeville WPCP	.	.	.	.	.	.	.	.	.	.	.	.
Harmony Cr. WPCP No.1 (Oshawa)	.	.	N	.	.	6	.	.	.	5/6	4/6	4/6
Harmony Cr. WPCP No.2 (Oshawa)	.	.	N	.	.	6	.	.	.	4/6	.	.
Peterborough WPCP	.	.	.	11	.	8/11	.	.	.	.	.	7/11
York-Durham WPCP (Pickering)	.	.	.	.	.	8	.	.	N	.	.	7
Picton WPCP	.	.	.	.	.	11	.	.	.	.	.	11
Seaway WPCP (Port Colborne)	.	.	N	11	10	5	.	.	N	.	11	6
Port Hope WPCP	.	.	.	.	.	.	.	.	.	.	.	.
Prescott-Edwardsburgh WPCP P	.	.	.	8	10	11	.	.	.	.	11	.
Port Dalhousie WPCP (St. Catharines)	.	.	.	.	.	.	.	.	.	11	.	.
Port Weller WPCP (St. Catharines)	.	.	.	11	.	.	.	.	.	.	11	10
Trenton WPCP	.	.	.	.	.	11	.	.	.	.	11	.
Welland WPCP	.	.	.	11	.	.	.	.	.	.	.	10
Corbett Cr. WPCP (Whitby)	.	.	.	8/10	9	9	.	.	.	10/11	.	.
Pringle Cr. WPCP No.1 (Whitby)	.	.	.	9	10	9	.	.	.	10	10	10
Pringle Cr. WPCP No.2 (Whitby)	.	.	N	10	9	8	.	.	.	8	8	7

P - Primary Plant
X - No Chemicals Used for P Removal
N - Not in Compliance
. - In Compliance

* Compliance based on MOE 1983 Effluent Criteria (Table 11).

TABLE 18. SUMMARY OF ANNUAL AND MONTHLY COMPLIANCE* FOR UPPER GREAT LAKES DRAINAGE BASIN (1984 & 1985)

PLANT		1984						1985					
		ANNUAL COMPLIANCE			MONTHLY COMPLIANCE (Mo's in Compliance)			ANNUAL COMPLIANCE			MONTHLY COMPLIANCE (Mo's in Compliance)		
		BOD	TSS	TP	BOD	TSS	TP	BOD	TSS	TP	BOD	TSS	TP
Barrie WPCP		.	.	.	.	.	8	.	.	.	.	.	.
Bradford WPCP		.	.	.	.	.	.	.	.	.	.	.	.
Collingwood WPCP		.	.	N	.	10/11	3/11	.	.	N	.	11	2
Esten Lake WPCP (Elliot Lake)		.	.	N	.	.	6	.	.	N	10	.	4
Goderich WPCP		.	.	N	.	.	4	.	.	.	.	.	9
Hanover WPCP		.	.	.	.	.	8	.	.	.	11	.	9
Huntsville WPCP		.	.	.	.	.	.	.	.	.	.	.	5/7
Midland WPCP		.	.	.	10/11	.	10/11	.	.	.	.	.	.
North Bay WPCP		.	.	N	10	7	10	.	N	N	9	3	0
Orillia WPCP		.	.	.	8/11	.	.	.	.	.	9	9	9
Owen Sound WPCP	P	.	.	.	9	.	10	.	.	.	.	.	9
Parry Sound WPCP		.	.	.	.	.	8	.	.	.	.	.	.
Port Elgin WPCP	X	.	.	N	.	.	1	.	.	N	.	.	1
Sault Ste. Marie WPCP	XP	.	.	N	.	.	0	.	.	N	.	.	0
Sturgeon Falls WPCP		.	.	.	.	.	.	.	.	.	.	.	.
Sudbury WPCP		.	.	N	.	.	0	.	.	N	.	.	0
Thunder Bay WPCP	P	.	.	N	11	6	2	.	.	N	.	.	8
Hamner, Val-Caron, Val-Therese WPCP (Valley East)		.	.	N	10	.	7	.	.	.	10	.	.
Mikkola WPCP (Walden)	X	.	.	N	.	10	0	.	.	N	.	.	0
Walkerton WPCP		.	.	.	10	.	8	.	.	.	10	.	7
Wasaga Beach WPCP	X	-	-	-	-	-	-	-	-	-	-	-	-

P - Primary Plant
X - No Chemicals Used for P Removal
N - Not in Compliance
. - In Compliance

* Compliance based on MOE 1983 Effluent Criteria (Table 11).

TABLE 19. NUMBER OF PLANTS IN ANNUAL AND MONTHLY COMPLIANCE WITH BOD_5/TSS/TP REQUIREMENTS FOR 1984 AND 1985

BASIN	TOTAL NUMBER OF PLANTS	1984						1985					
		IN COMPLIANCE ANNUALLY*			IN COMPLIANCE MONTHLY*			IN COMPLIANCE ANNUALLY*			IN COMPLIANCE MONTHLY*		
		BOD_5	TSS	TP	BOD_5	TSS	TP	BOD_5	TSS	TP	BOD_5	TSS	TP
Lake Erie	31 (100%)	27 (87.1%)	29 (93.5%)	27 (87.1%)	19 (61.3%)	23 (74.2%)	10 (32.3%)	30 (96.8%)	30 (96.8%)	28 (90.3%)	23 (74.2%)	24 (77.4%)	10 (32.3%)
Lake Ontario & St. Lawrence	44 (100%)	40 (90.9%)	42 (95.5%)	32 (72.9%)	24 (54.5%)	28 (63.6%)	7 (15.9%)	43 (97.7%)	42 (95.5%)	36 (81.8%)	26 (59.1%)	24 (54.4%)	17 (38.6%)
Upper Great Lakes	21 (100%)	20 (95.2%)	20 (95.2%)	10 (47.6%)	13 (61.9%)	17 (81.0%)	4 (19.0%)	20 (95.2%)	19 (90.5%)	12 (57.1%)	14 (66.7%)	17 (81.0%)	6 (28.6%)
TOTAL	96 (100%)	77 (80.2%)	90 (93.8%)	69 (71.9%)	57 (59.4%)	68 (70.8%)	21 (21.9%)	93 (96.9%)	92 (95.8%)	77 (80.2%)	63 (65.6%)	65 (67.7%)	33 (34.4%)

* Compliance based on MOE 1983 Effluent Criteria (Table 11).

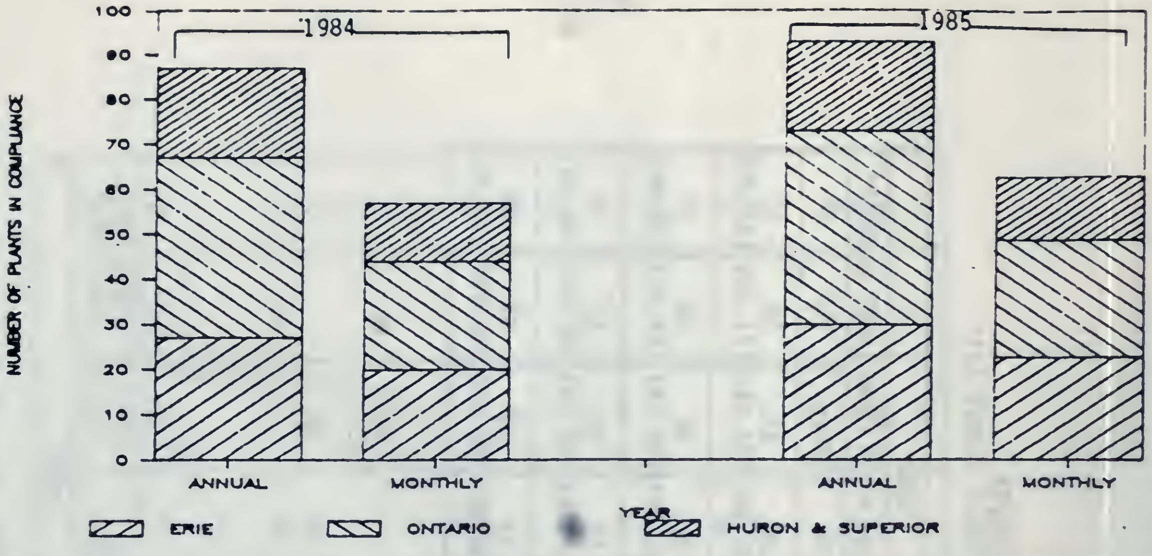

FIGURE 7 - COMPARISON OF BOD_5 COMPLIANCE STATUS BASED ON ANNUAL AND MONTHLY ASSESSMENT FOR 1984 AND 1985

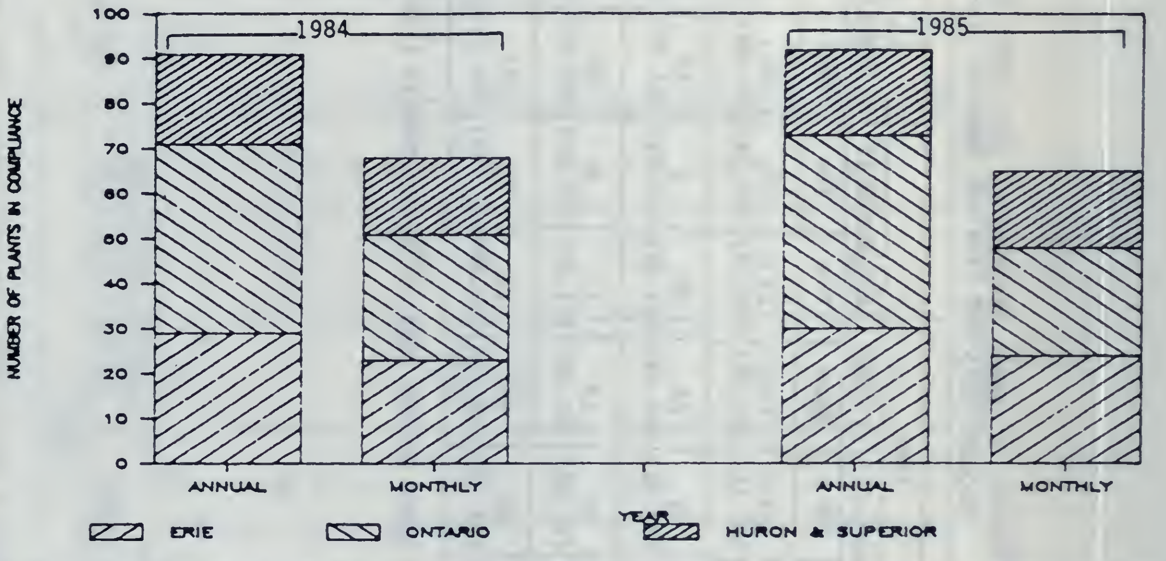

FIGURE 8 - COMPARISON OF TSS COMPLIANCE STATUS BASED ON ANNUAL AND MONTHLY ASSESSMENT FOR 1984 AND 1985

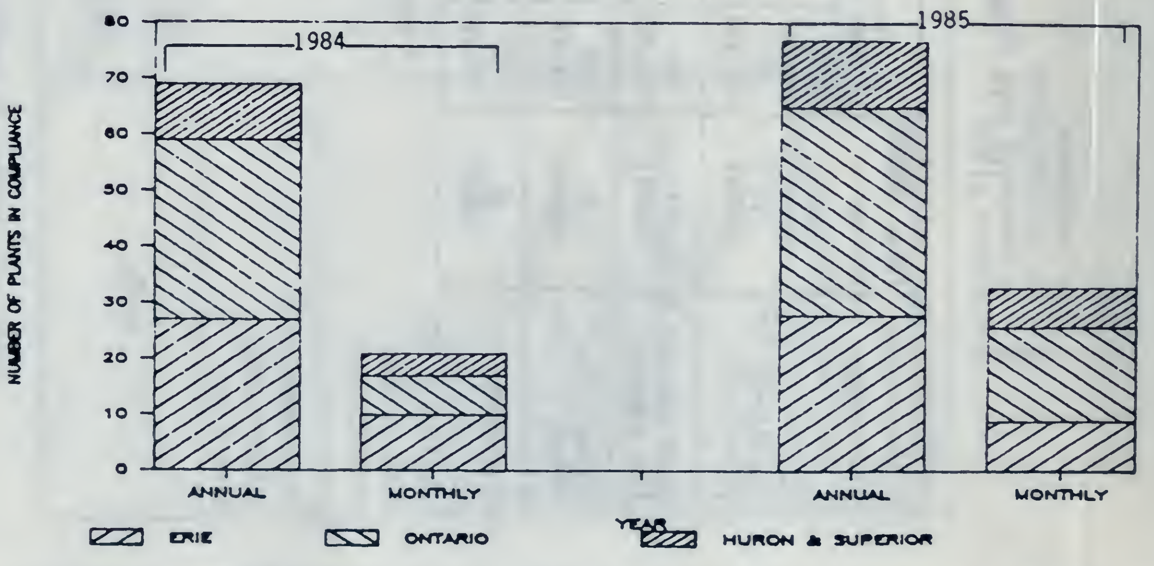

FIGURE 9 - COMPARISON OF TP COMPLIANCE STATUS BASED ON ANNUAL AND MONTHLY ASSESSMENT FOR 1984 AND 1985

significantly fewer plants in compliance when evaluated on a monthly average basis for all parameters. The largest difference was consistently for TP, with up to 50% (1984 total, Table 18) more plants being in compliance when evaluated on an annual average than on a monthly average basis. In the Lake Erie Basin, only one plant (Kitchener WPCP) was in compliance with the BOD_5, TSS and TP effluent requirements for both 1984 and 1985 when compliance was assessed on a monthly average basis. In the Lake Ontario/St. Lawrence River Basin, only three plants (Milton, Orangeville and Port Hope) were in compliance with all requirements for both years based on monthly average effluent concentration. In the upper Great Lakes Basin, two plants (Bradford and Sturgeon Falls) were in this compliance category. Overall, 7 plants (6.3 percent of the total) were in compliance with all effluent quality requirements (BOD_5, TSS, TP) for all months of 1984 and 1985.

Figures 10 to 12 present histograms showing the number of months during 1984 and 1985 that plants exceeded the effluent requirements for BOD_5, TSS and TP, respectively. Approximately two-thirds of the 96 plants evaluated were consistently in compliance with the BOD_5 and TSS requirements (zero months out-of-compliance) in 1984 and 1985. Of those that were out-of-compliance, the majority exceeded the effluent requirement for three months or less. Conversely, almost fifty percent of the plants were out-of-compliance with the TP requirement for between 1 and 6 months of 1984 and 1985 and more than ten percent of these plants exceeded the 1 mg/L effluent TP requirement for more than half of 1984 and 1985 (more than 6 months of each year).

Tables 20 to 22 present the average effluent concentration of BOD_5, TSS and TP for each plant for those months that were not in compliance with the effluent requirement. With a few exceptions, the average effluent TP concentration during months not in compliance with the 1 mg/L requirement is in the range of 1.0 to 1.5 mg/L. Exceptions were generally primary treatment facilities and plants not adding chemicals to achieve phosphorus removal.

4.1.3 Plant Phosphorus Removal Status

Tables 23 to 28 summarize plant performance status for 1984 and 1985 on an individual basin basis (Lake Erie, Lake Ontario/St. Lawrence River, Upper Great Lakes). Plants in each basin have been grouped in categories based on the annual average effluent TP concentration achieved during

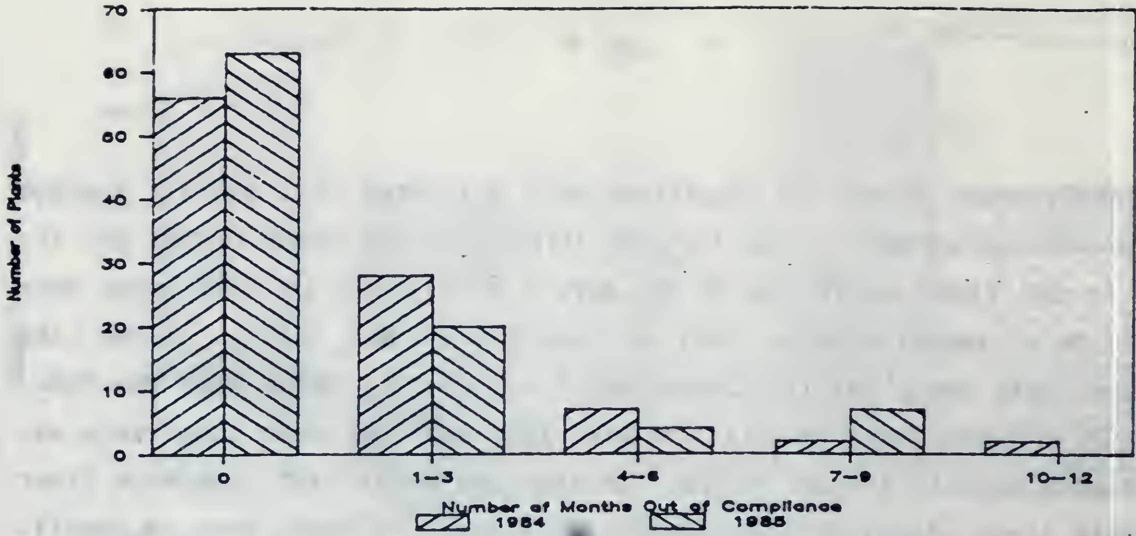

FIGURE 10 - MONTHLY BOD_5 COMPLIANCE FOR 96 PLANTS IN ONTARIO

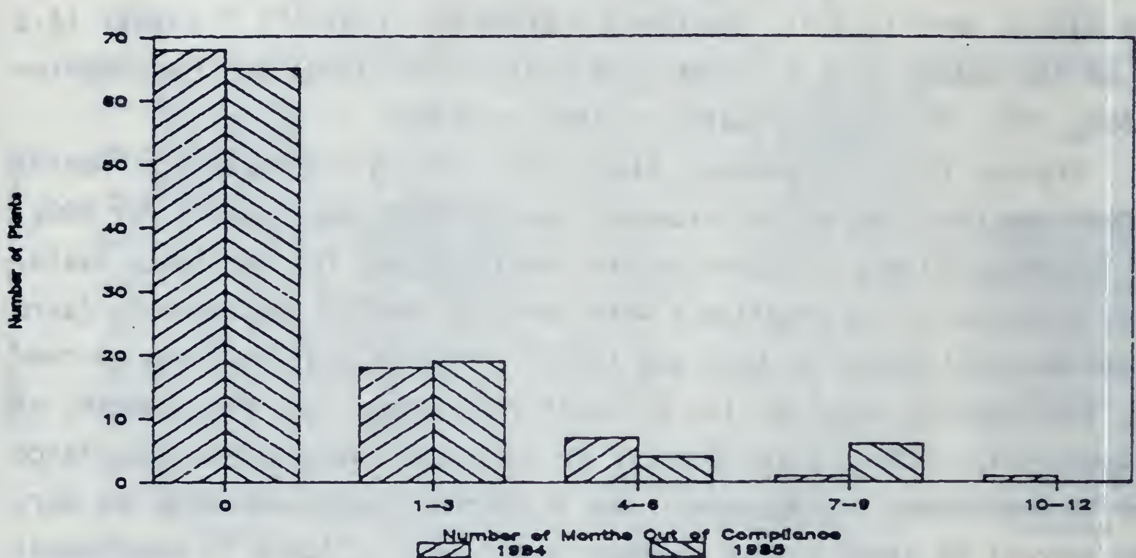

FIGURE 11 - MONTHLY TSS COMPLIANCE FOR 96 PLANTS IN ONTARIO

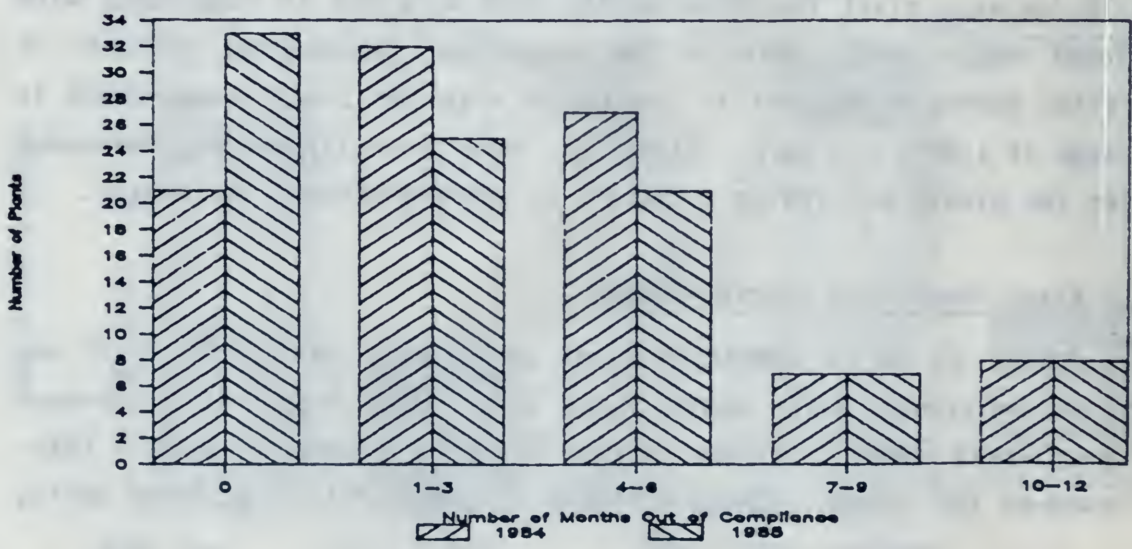

FIGURE 12 - MONTHLY TP COMPLIANCE FOR 96 PLANTS IN ONTARIO

TABLE 20. LAKE ERIE NON-COMPLIANCE AVERAGES FOR 1984 & 1985

PLANT		BOD_5			TSS			TP		
		# MO's DATA	# MO's O of C*	AVERAGE FOR MO's O of C*	# MO's DATA	# MO's O of C*	AVERAGE FOR MO's O of C*	# MO's DATA	# MO's O of C*	AVERAGE FOR MO's O of C
Amhurstburg WPCP	P	21	13	46.1	20	9	35.5	22	20	3.98
Brantford WPCP		24	0	-	24	0	-	24	1	1.05
Galt WPCP (Cambridge)		23	1	26.3	24	2	27.4	24	2	1.04
Hespeler WPCP (Cambridge)		22	14	36.4	22	12	38.6	24	10	1.57
Preston WPCP (Cambridge)		24	8	35.4	24	3	48.7	23	2	1.50
Chatham WPCP		24	0	-	24	3	28.3	24	5	1.36
Dresden WPCP		24	0	-	24	0	-	24	3	1.37
Dunnville WPCP		24	3	99.8	24	2	47.3	24	3	2.53
Fergus WPCP		24	0	-	24	8	30.0	24	0	-
Guelph WPCP		24	1	26.8	24	0	-	24	8	1.20
Ingersoll New WPCP		24	0	-	24	0	-	24	5	1.53
Kitchener WPCP		23	0	-	23	0	-	24	0	-
Leamington WPCP		22	1	44.8	22	3	43.9	22	6	1.47
Adelaide WPCP (London)		24	0	-	24	0	-	24	2	1.10
Greenway WPCP (London)		24	0	-	24	0	-	24	6	1.22
Oxford WPCP (London)		24	0	-	24	0	-	24	3	1.30
Pottersburg WPCP (London)		24	0	-	24	0	-	24	1	1.10
Vauxhall WPCP (London)		24	0	-	24	0	-	24	2	1.15
Belle River - Maidstone WPCP		24	0	-	24	0	-	24	5	1.21
Corunna P.V. Plant (Moore)		24	0	-	24	1	27.4	24	12	1.29
Paris WPCP	P	24	2	24.4	24	0	-	24	1	1.13
Sarnia WPCP		21	18	47.3	24	5	33.2	23	1	1.52
Simcoe WPCP		24	2	93.8	24	2	79.8	24	1	1.38
St. Thomas WPCP		23	1	39.7	23	2	40.0	23	11	1.55
Stratford WPCP		24	2	26.9	24	0	-	24	0	-
Tillsonburg WPCP		24	0	-	24	0	-	24	1	1.45
Wallaceburg WPCP		24	1	27.0	23	0	-	21	3	1.23
Waterloo WPCP		24	2	31.5	24	0	-	24	5	1.34
Little River WPCP (Windsor)		24	0	-	24	0	-	24	8	1.91
Westerly WPCP (Windsor)	P	24	7	28.1	24	1	26.0	24	3	1.13
Woodstock WPCP		24	0	-	24	1	28.0	23	7	1.19

* Out of Compliance based on BOD/TSS/TP = 25/25/1 mg/L.

P - Primary Plant

TABLE 21. LAKE ONTARIO/ST. LAWRENCE NON-COMPLIANCE AVERAGES FOR 1984 & 1985

PLANT	BOD$_5$			TSS			TP		
	# MO's DATA	# MO's 0 of C*	AVERAGE FOR MO's 0 of C*	# MO's DATA	# MO's 0 of C*	AVERAGE FOR MO's 0 of C*	# MO's DATA	# MO's 0 of C*	AVERAGE FOR MO' 0 of C
Belleville WPCP P	24	9	42.8	24	4	38.3	24	4	1.56
Brockville WPCP	18	8	33.3	18	3	29.2	24	8	1.20
Skyway WPCP (Burlington)	23	0	-	23	0	-	24	2	1.48
Campbellford WPCP X	21	0	-	22	0	-	24	4	1.24
Cobourg WPCP No.1 X	23	1	31.1	23	0	-	22	5	3.13
Cornwall WPCP P	24	22	45.1	24	8	30.8	24	10	1.20
Dundas WPCP	24	0	-	24	1	30.0	24	7	1.19
Anger Ave. WPCP (Fort Erie) P	22	15	37.4	22	10	33.9	22	4	1.18
Baker Rd. WPCP (Grimsby)	22	1	26.0	22	0	-	24	1	1.04
Acton WPCP + Lagoon (Halton Hills)	23	0	-	23	0	-	24	2	1.34
Georgetown WPCP (Halton Hills)	24	1	27.0	24	0	-	24	5	1.75
Woodward Ave. WPCP X	24	7	35.3	24	6	34.5	24	17	1.49
Iroquois WPCP P	9	8	123.7	9	9	83.5	8	6	2.59
Kingston WPCP P	24	6	31.2	24	11	38.3	24	6	1.19
Kingston Twp. WPCP	18	2	28.5	18	2	28.0	18	2	1.18
Highland Creek WPCP (Metro Toronto)	24	11	36.1	24	6	31.7	24	2	1.10
Humber WPCP (Metro Toronto)	24	0	-	24	6	36.3	24	16	1.50
Main WPCP (Metro Toronto)	24	7	30.4	24	5	39.4	24	11	1.27
North Toronto WPCP (Metro Toronto)	24	1	26.0	24	0	-	24	5	1.13
Milton WPCP	22	0	-	22	0	-	20	0	-
Clarkson WPCP (Mississauga)	24	0	-	24	0	-	24	3	1.13
Lakeview WPCP (Mississauga)	24	0	-	24	3	27.0	24	2	1.17
Napanee WPCP	18	0	-	18	1	28.0	24	15	2.26
Port Darlington WPCP (Newcastle)	21	3	53.7	21	2	38.1	21	9	2.16
Stamford WPCP (Niagara Falls) P	24	17	42.6	24	15	30.9	24	1	1.07
South East WPCP (Oakville)	23	0	-	23	0	-	23	7	1.25
South West WPCP (Oakville)	23	0	-	23	2	26.3	23	7	1.49
Orangeville WPCP	24	0	-	24	0	-	24	0	-
Harmony Creek WPCP No.1 (Oshawa)	18	1	60.0	18	2	41.4	24	7	1.45
Harmony Creek WPCP No.2 (Oshawa)	18	1	41.0	18	0	-	24	6	1.50
Peterborough WPCP	22	1	28.0	22	0	-	24	6	1.33
York-Durham WPCP (Pickering)	23	0	-	23	1	34.0	24	8	1.26
Picton WPCP	17	0	-	17	1	32.0	24	1	2.50
Port Colborne WPCP (Seaway)	24	1	33.7	24	3	33.5	24	13	1.57
Port Hope WPCP	23	0	-	23	0	-	23	0	-
Prescott-Edwardsburgh WPCP P	24	3	29.3	24	9	37.9	24	1	1.20
Port Dalhousie WPCP (St. Catharines)	24	1	27.0	24	0	-	24	0	-
Port Weller WPCP (St. Catharines)	24	1	23.0	24	1	33.8	24	2	1.11
Trenton WPCP	24	0	-	24	1	26.0	24	1	1.20
Welland WPCP	22	1	25.5	22	0	-	24	2	1.10
Corbett Creek WPCP (Whitby)	21	3	66.7	23	3	35.7	24	3	1.21
Pringle Creek WPCP No.1 (Whitby)	23	4	71.4	23	4	36.8	24	5	1.51
Pringle Creek WPCP No.2 (Whitby)	23	5	70.0	23	6	31.8	23	8	1.37

* Out of Compliance based on BOD/TSS/TP = 25/25/1 mg/L.

P - Primary Plant

X - No Chemicals Used for P Removal

TABLE 22. UPPER GREAT LAKES NON-COMPLIANCE AVERAGES FOR 1984 & 1985

PLANT		BOD_5			TSS			TP	
	# MO's DATA	# MO's 0 of C*	AVERAGE FOR MO's 0 of C*	# MO's DATA	# MO's 0 of C*	AVERAGE FOR MO's 0 of C*	# MO's DATA	# MO's 0 of C*	AVERAGE FOR MO's 0 of C
Barrie WPCP	24	0	-	24	1	33.0	23	4	1.28
Bradford WPCP	23	0	-	24	0	-	23	0	--
Collingwood WPCP	24	0	-	23	2	34.5	23	18	1.98
Esten Lake WPCP (Elliot Lake)	22	2	45.5	24	0	-	24	13	1.78
Goderich WPCP	24	0	-	24	0	-	24	11	1.32
Hanover WPCP	24	1	29.2	24	0	-	24	7	1.20
Huntsville WPCP	15	0	-	19	1	43.1	19	2	1.81
Midland WPCP	22	1	43.8	22	0	0	22	1	1.12
North Bay WPCP	24	5	30.1	24	14	34.9	24	22	1.67
Orillia WPCP	19	6	38.5	20	3	47.2	20	3	1.54
Owen Sound WPCP P	23	10	30.6	23	9	27.5	23	5	1.07
Parry Sound WPCP	24	0	-	24	0	-	24	4	1.24
Port Elgin WPCP X	24	1	75.0	24	0	-	24	22	1.87
Sault Ste. Marie WPCP X P	24	24	83.2	24	24	60.9	24	24	4.42
Sturgeon Falls WPCP	24	0	-	24	0	-	22	0	-
Sudbury WPCP X	24	1	26.9	24	0	-	24	24	1.97
Thunder Bay WPCP P	24	23	54.3	24	22	36.1	24	14	1.40
Hamner, Val-Caron, Val-Therese WPCP (Valley East)	24	4	30.8	24	0	-	23	5	1.85
Mikkola WPCP (Walden) X	24	0	-	24	0	26.9	24	24	2.50
Walkerton WPCP	24	5	28.5	24	2	-	24	9	1.19

* Out of Compliance based on BOD/TSS/TP = 25/25/1 mg/L.

P - Primary Plant

X - No Chemicals Used for P Removal

TABLE 23. SUMMATION OF PLANT PHOSPHORUS REMOVAL STATUS FOR 1984
LAKE ERIE DRAINAGE BASIN

PLANTS ACHIEVING TP < 0.5 mg/L		PLANTS ACHIEVING 0.5 < TP < 0.75 mg/L	PLANT ACHIEVING 0.75 < TP <1.0 mg/L	PLANTS ACHIEVING 1.0 < TP < 1.25 mg/L	PLANTS ACHIEVING TP > 1.25 mg/L	PLANTS NOT COMPLYING WITH ANNUAL AVERAGE	PLANTS COMPLYING WITH MONTHLY AVERAGE
Tillsonburg WPCP		Brantford WPCP Preston WPCP (Cambridge) Dresden WPCP Fergus WPCP Ingersoll New WPCP Kitchener WPCP Leamington WPCP Belle River-Maidstone WPCP Paris WPCP Stratford WPCP Wallaceburg WPCP Westerly WPCP (Windsor)	Galt WPCP (Cambridge) Hespeler WPCP (Cambridge) Chatham WPCP Guelph WPCP Adelaide WPCP (London) Greenway WPCP (London) Oxford WPCP (London) Pottersburg WPCP (London) Vauxhall WPCP (London) Corunna P.V. Plant (Moore) Sarnia WPCP Simcoe WPCP Waterloo WPCP Woodstock WPCP	Dunnville WPCP St. Thomas WPCP Little R. WPCP (Windsor)	Amhurstburg WPCP	Amhurstburg WPCP Dunnville WPCP St. Thomas WPCP Little R. WPCP (Windsor)	Brantford WPCP Preston WPCP (Cambridge) Chatham WPCP Fergus WPCP Kitchener WPCP Pottersburg WPCP (London) Paris WPCP Sarnia WPCP Stratford WPCP Tillsonburg WPCP
Number Of Plants	1	12	14	3	1	4	10
Total Flow (10^3 m^3/day) (100%)	5.3 (0.77%)	284.57 (35.8%)	420.79 (52.9%)	79.77 (10.0%)	4.546 (0.06%)	84.32 (10.6%)	262.02 (33.0%)
Total P Loading (kg/day) (100%)	2.12 (0.3%)	196.31 (28.5%)	376.027 (54.6%)	95.42 (13.9%)	19.09 (2.8%)	114.51 (16.7%)	187.31 (27.3%)
Aggregate Average TP Concentration (mg/L)	0.40	0.69	0.90	1.20	4.20	1.36	0.72

TABLE 24. SUMMATION OF PLANT PHOSPHORUS REMOVAL STATUS FOR 1985
LAKE ERIE DRAINAGE BASIN

	PLANTS ACHIEVING TP < 0.5 mg/L	PLANTS ACHIEVING 0.5 < TP < 0.75 mg/L	PLANT ACHIEVING 0.75 < TP <1.0 mg/L	PLANTS ACHIEVING 1.0 < TP < 1.25 mg/L	PLANTS ACHIEVING TP > 1.25 mg/L	PLANTS NOT COMPLYING WITH ANNUAL AVERAGE	PLANTS COMPLYING WITH MONTHLY AVERAGE
	Dresden WPCP Stratford WPCP Wallaceburg WPCP	Dunnville WPCP Fergus WPCP Oxford WPCP (London) Pottersburg WPCP (London) Vauxhall WPCP (London) Paris WPCP Simcoe WPCP Waterloo WPCP	Brantford WPCP Galt WPCP (Cambridge) Preston WPCP (Cambridge) Chatham WPCP Guelph WPCP Ingersoll New WPCP Kitchener WPCP Leamington WPCP Adelaide WPCP (London) Greenway WPCP (London) Belle River-Maidstone WPCP Corunna P.V. Plant Sarnia WPCP Tillsonburg WPCP Little R. WPCP (Windsor) Westerly WPCP (Windsor)	St. Thomas WPCP Woodstock WPCP	Amhurstburg WPCP Hespeler WPCP (Cambridge)	Amhurstburg WPCP Hespeler WPCP (Cambridge) St. Thomas WPCP Woodstock WPCP	Galt WPCP (Cambridge) Dresden WPCP Dunnville WPCP Fergus WPCP Kitchener WPCP Adelaide WPCP (London) Oxford WPCP (London) Simcoe WPCP Stratford WPCP
Number Of Plants	3	8	15	2	2	4	9
Total Flow (10^3 m^3/day) (100%)	36.19 (4.3%)	108.33 (12.9%)	639.61 (76.4%)	42.84 (5.1%)	10.05 (1.2%)	52.89 (6.3%)	164.9 (19.7%)
Total P Loading (kg/day) (100%)	10.38 (1.5%)	74.02 (11.0%)	520.22 (77.4%)	45.59 (6.8%)	21.99 (1.2%)	67.58 (10.1%)	111.97 (16.7%)
Aggregate Average TP Concentration (mg/L)	0.29	0.68	0.81	1.06	2.19	1.28	0.68

TABLE 25. SUMMATION OF PLANT PHOSPHORUS REMOVAL STATUS FOR 1984
LAKE ONTARIO/ST. LAWRENCE DRAINAGE BASIN

	PLANTS ACHIEVING TP < 0.5 mg/L	PLANT ACHIEVING 0.5 < TP < 0.75 mg/L	PLANT ACHIEVING 0.75 < TP <1.0 mg/L	PLANTS ACHIEVING 1.0 < TP < 1.25 mg/L	PLANTS ACHIEVING TP > 1.25 mg/L	PLANTS NOT COMPLYING WITH ANNUAL AVERAGE	PLANTS COMPLYING WITH MONTHLY AVERAGE
	Milton WPCP Orangeville WPCP	Skyway WPCP (Burlington) Bolton WPCP(Caledon) Campbellford WPCP Cobourg WPCP No. 1 Baker Rd. WPCP (Grimsby) Acton WPCP & Lag. (Halton Hills) Stamford WPCP (Niagara Falls) Picton WPCP Port Hope WPCP Port Dalhousie WPCP (St. Catharines) Port Weller WPCP (St. Catharines) Trenton WPCP Welland WPCP	Cornwall WPCP Dundas WPCP Anger Ave. WPCP(Fort Erie) Kingston WPCP Kingston TWP. WPCP Highland Cr. WPCP (Metro Toronto) Main WPCP (Metro Toronto) North Toronto WPCP (Metro Toronto) Clarkson WPCP(Mississauga) Lakeview WPCP(Mississauga) South East WPCP (Oakville) South West WPCP (Oakville) Peterborough WPCP York-Durham WPCP (Pickering) Prescott-Edwardsburgh WPCP Corbett Cr. WPCP (Whitby) Pringle Cr. WPCP No. 1 (Whitby)	Belleville WPCP Brockville WPCP Georgetown WPCP (Halton Hills) Harmony Cr. 1 & 2 (Oshawa) Seaway WPCP (Port Colborne) Pringle Cr. WPCP No.2 (Whitby)	Woodward Ave. WPCP (Hamilton) Iroquois WPCP Humber WPCP (Metro Toronto) Napanee WPCP Port Darlington WPCP (Newcastle)	Belleville WPCP Brockville WPCP Georgetown WPCP (Halton Hills) Harmony Cr. 1 & 2 WPCP (Oshawa) Seaway WPCP (Port Colborne) Pringle Cr. WPCP No. 2 (Whitby) Woodward Ave. WPCP (Hamilton) Iroquois WPCP Humber WPCP (Metro Toronto) Napanee WPCP Port Darlington WPCP (Newcastle)	Milton WPCP Orangeville WPCP Port Hope WPCP Port Dalhousie WPCP (St. Catharines) Port Weller WPCP (St. Catharines) Welland WPCP
Number of Plants	2	13	17	7	5	12	6
Total Flow (10^3 m^3/day) (100%)	17.25 (0.6%)	312.52 (11.7%)	1525.5 (57.0%)	143.8 (5.4%)	678.71 (25.3%)	822.51 (30.7%)	146.9 (5.5%)
Total P Loading (kg/day) (100%)	6.18 (0.2%)	188.62 (7.0%)	1415.2 (52.6%)	150.29 (5.6%)	929.91 (34.6%)	1080.11 (40.1%)	83.3 (3.1%)
Aggregate Average TP Concentration (mg/L)	0.36	0.60	0.93	1.04	1.37	1.31	0.57

TABLE 26. SUMMATION OF PLANT PHOSPHORUS REMOVAL STATUS FOR 1985
LAKE ONTARIO/ST. LAWRENCE DRAINAGE BASIN

	PLANTS ACHIEVING TP < 0.5 mg/L	PLANTS ACHIEVING 0.5 < TP < 0.75 mg/L	PLANT ACHIEVING 0.75 < TP <1.0 mg/L	PLANTS ACHIEVING 1.0 < TP < 1.25 mg/L	PLANTS ACHIEVING TP < 1.25 mg/L	PLANTS NOT COMPLYING WITH ANNUAL AVERAGE	PLANTS COMPLYING WITH MONTHLY AVERAGE
	Belleville WPCP Bolton WPCP(Caledon) Acton WPCP (Halton Hills) Milton WPCP Stamford WPCP (Niagara Falls) Orangeville WPCP Port Dalhousie WPCP (St. Catharines)	Skyway WPCP (Burlington) Anger Ave. WPCP (Fort Erie) Baker Rd. WPCP (Grimsby) Georgetown WPCP (Halton Hills) Lakeview WPCP (Mississauga) Harmony Cr. No. 1 WPCP (Oshawa) Harmony Cr. No. 2 WPCP (Oshawa) Picton WPCP Port Hope WPCP Prescott-Edwardsburgh WPCP Trenton WPCP Welland WPCP Corbett Cr. WPCP(Whitby) Pringle Cr. WPCP No. 1 (Whitby)	Brockville WPCP Campbellford WPCP Cornwall WPCP Dundas WPCP Kingston WPCP Kingston TWP WPCP Highland Cr. WPCP (Metro Toronto) North Toronto WPCP Clarkson WPCP (Mississauga) Port Darlington WPCP (Newcastle) South East WPCP (Oakville) South West WPCP (Oakville) Peterborough WPCP Port Weller WPCP (St. Catharines) Pringle Cr. WPCP No.2 (Whitby)	Humber WPCP (Metro Toronto) Main WPCP (Metro Toronto) Napanee WPCP York Durham WPCP (Pickering) Seaway WPCP (Port Colborne)	Cobourg WPCP No. 1 Woodward Ave. WPCP (Hamilton)	Cobourg WPCP No. 1 Woodward Ave. WPCP (Hamilton) Humber WPCP (Metro Toronto) Main WPCP (Metro Toronto) Napanee WPCP York Durham WPCP (Pickering) Seaway WPCP (Port Colborne)	Belleville WPCP Acton WPCP (Halton Hills) Georgetown WPCP (Halton Hills) Kingston WPCP Highland Cr. (Metro Toronto) Milton WPCP Lakeview WPCP (Mississauga) Stamford WPCP (Niagara Falls) Orangeville WPCP Picton WPCP Port Hope WPCP Prescott-Edwardsburg WPCP Port Dalhousie WPCP (St. Catharines) Trenton WPCP Corbett Cr. WPCP(Whitby)
Number of Plants	7	14	15	5	2	7	15
Total Flow (10^3 m^3/day) (100%)	166.89 (6%)	466.85 (16.8%)	592.51 (21.4%)	1229.82 (44.4%)	316.28 (11.4%)	1548.10 (55.8%)	676.7 (24.4%)
Total P Loading (kg/day) (100%)	70.37 (2.7%)	295.87 (11.4%)	491.65 (19.0%)	1313.71 (50.8%)	413.88 (16.0%)	1727.59 (66.8%)	425.8 (16.5%)
Aggregate Average TP Concentration (mg/L)	0.42	0.63	0.83	1.07	1.31	1.12	0.63

TABLE 27. SUMMATION OF PLANT PHOSPHORUS REMOVAL STATUS FOR 1984
LAKE HURON DRAINAGE BASIN

	PLANTS ACHIEVING TP < 0.5 mg/L	PLANT ACHIEVING 0.5 < TP < 0.75 mg/L	PLANT ACHIEVING 0.75 < TP <1.0 mg/L	PLANTS ACHIEVING 1.0 < TP < 1.25 mg/L	PLANTS ACHIEVING TP > 1.25 mg/L	PLANTS NOT COMPLYING WITH ANNUAL AVERAGE	PLANTS COMPLYING WITH MONTHLY AVERAGE
	Huntsville WPCP Orillia WPCP Sturgeon Falls WPCP	Midland WPCP	Barrie WPCP Bradford WPCP Hanover WPCP Owen Sound WPCP Parry Sound WPCP Walkerton WPCP	Goderich WPCP Hamner, Val-Caron, Val-Therese WPCP (Valley East)	Collingwood WPCP Esten Lake WPCP (Elliot Lake) North Bay WPCP Port Elgin WPCP Sault Ste. Marie WPCP Sudbury WPCP Thunder Bay WPCP* Mikkola WPCP (Walden)	Collingwood WPCP Eastern L. WPCP (Elliott Lake) Goderich WPCP North Bay WPCP Port Elgin WPCP Sault Ste. Marie WPCP Sudbury WPCP Thunder Bay WPCP* Hamner, Val-Caron, Val-Therese WPCP (Valley East) Mikkola WPCP (Walden)	Bradford WPCP Huntsville WPCP Orillia WPCP Sturgeon Falls WPCP
Number of Plants	3	1	6	2	7	9	3
Total Flow (10^3 m^3/day) (100%)	29.75 (10.6%)	9.29 (3.3%)	61.54 (21.9%)	14.71 (5.2%)	166.12 (59.0%)	180.83 (64.2%)	29.75 (10.57)
Total P Loading (kg/day) (100%)	11.20 (2.6%)	5.17 (1.2%)	55.81 (13.0%)	16.38 (3.9%)	335.73 (79.1%)	352.11 (83.0%)	11.2 (2.6%)
Aggregate Average TP Concentration (mg/L)	0.38	0.56	0.91	1.11	2.02	1.95	0.35

* Thunder Bay WPCP is not included in Basin Values at bottom since it discharges into Lake Superior Drainage Basin.

TABLE 28. SUMMATION OF PLANT PHOSPHORUS REMOVAL STATUS FOR 1985
LAKE HURON DRAINAGE BASIN

	PLANTS ACHIEVING TP < 0.5 mg/L	PLANT ACHIEVING 0.5 < TP < 0.75 mg/L	PLANT ACHIEVING 0.75 < TP <1.0 mg/L	PLANTS ACHIEVING 1.0 < TP < 1.25 mg/L	PLANTS ACHIEVING TP < 1.25 mg/L	PLANTS NOT COMPLYING WITH ANNUAL AVERAGE	PLANTS COMPLYING WITH MONTHLY AVERAGE
	Bradford WPCP Sturgeon Falls WPCP	Barrie WPCP Midland WPCP Parry Sound WPCP Hamner Etc. WPCP (Valley East)	Goderich WPCP Hanover WPCP Huntsville WPCP Orillia WPCP Owen Sound WPCP Thunder Bay WPCP* Walkerton WPCP	Esten L. WPCP (Elliot Lake)	Collingwood WPCP North Bay WPCP Port Elgin WPCP Sault Ste. Marie WPCP Sudbury WPCP Mikkola WPCP (Walden)	Collingwood WPCP Esten L. WPCP (Elliott Lake) North Bay WPCP Port Elgin WPCP Sault Ste. Marie WPCP Sudbury WPCP Mikkola WPCP (Walden)	Barrie WPCP Bradford WPCP Midland WPCP Parry Sound WPCP Sturgeon Falls WPCP Hamner Etc. (Valley East)
Number of Plants	2	4	6	1	6	7	7
Total Flow (10^3 m^3/day) (100%)	8.68 (2.8%)	46.54 (15.5%)	67.56 (22.4%)	12.05 (4.0%)	166.4 (55.2%)	178.45 (59.2%)	60.02 (9.6%)
Total P Loading (kg/day) (100%)	3.56 (0.7%)	25.16 (4.6%)	56.96 (10.5%)	5.03 (0.9%)	450.55 (83.2%)	455.58 (84.19)	32.37 (5.2%)
Aggregate Average TP Concentration (mg/L)	0.41	0.54	0.84	1.10	2.53	2.38	0.54

* Thunder Bay WPCP is not included in Basin Values at bottom since it discharges into Lake Superior Drainage Basin.

each year. Also included in these summary tables are the plants that did not comply with the annual average TP requirement and those that complied with the monthly average TP requirement.

From the plant status summaries, basin flows, loadings and aggregate average TP concentrations for each status group were calculated. These values show the contribution from each status group to the flows and phosphorus loadings to the drainage basin. For example, Table 23 shows that the plants in the Lake Erie drainage basin in 1984 that were not in compliance with respect to TP contributed 10.6% of the total basin flow and 16.7% of the total basin TP loading. In the Lake Ontario Basin, the 1984 (Table 24) flow contribution of plants not in compliance with the annual average TP requirement was 822.51 x 10^3 m^3/d (30.7 percent of the total) and the TP loading from these plants was 1080 kg/d (40.1 percent of the total TP loading). In the Upper Great Lakes Basin, these plants in 1984 (Table 26) contributed 64 percent of the basin flow and 83 percent of the TP loading.

From the data presented in Tables 23 to 28, it is apparent that the overall impact on the total basin TP loading of bringing plants into compliance with the 1 mg/L effluent requirement is more strongly influenced by the size of out-of-compliance plants and the effluent concentration at these plants than by the number of plants out-of-compliance.

From the information in Tables 23 to 28, the ranges of annual average concentrations found for all plants that complied on a monthly average basis were observed. For both 1984 and 1985, about 30 percent of all plants that complied on a monthly basis had annual average concentrations less than 0.5 mg/L, 50 percent had concentrations between 0.5 and 0.75 mg/L nd 20 percent had concentrations greater than 0.75 mg/L. It can be noted that in order to achieve monthly compliance, the majority of plants had to maintain annual average concentrations less than 0.75 mg/L. However, some plants did achieve monthly compliance with higher annual averages (>0.75 mg/L). This suggests that with good plant operation and monitoring and low influent phosphorus and flow variability, higher annual average concentrations can be maintained, while complying on a monthly basis. These results cannot be validated because in 1984 and 1985 plants were not attempting to achieve monthly phosphorus compliance.

4.1.4 Effect of Sampling Frequency

Plants that sample more frequently may better be able to control their chemical usage and ultimately their average effluent phosphorus concentrations. To determine if sampling frequency has an effect on the annual average phosphorus concentration, the number of samples upon which effluent phosphorus averages were based in 1984 and 1985 were reviewed relative to the reported concentrations.

Figure 13 presents a histogram of the number of plants and the frequency that they were sampling in 1984 and 1985. It can be observed that about 24 plants (>24%) were not doing any effluent phosphorus sampling other than the required monthly (or bimonthly) analyses done at regional MOE laboratories. About 40 (>40%) of the plants were doing on-site analyses more than twice per week.

Figures 14 and 15 compare the number of effluent TP samples taken in 1984 and 1985 at each plant to the annual average effluent TP concentration. It can be observed that annual average effluent concentrations tend to deviate more from the ideal 1 mg/L when less than 50 samples (<1/wk) were taken. Where greater than 50 samples (>1/wk) were taken, there does not appear to be any trend of increased efficiency with an increased number of samples. A number of reasons for the lack of trends indicated by these plots can be suggested:

1. Plants that are sampling regularly are not using the obtained results to adjust chemical dosages.
2. Depending on the type of sample taken (grab or composite) and time of day, sample analysis may not be representative of the actual average TP concentration.
3. Infrequent sampling (i.e. <1/wk) does not allow for a damping effect for high or low days due to rainfall, industry peaks and shutdowns (e.g. weekends).
4. On-site analytical methods may be inaccurate.

In summary, there was found to be little or no correlation between sampling frequency and annual average effluent phosphorus concentrations.

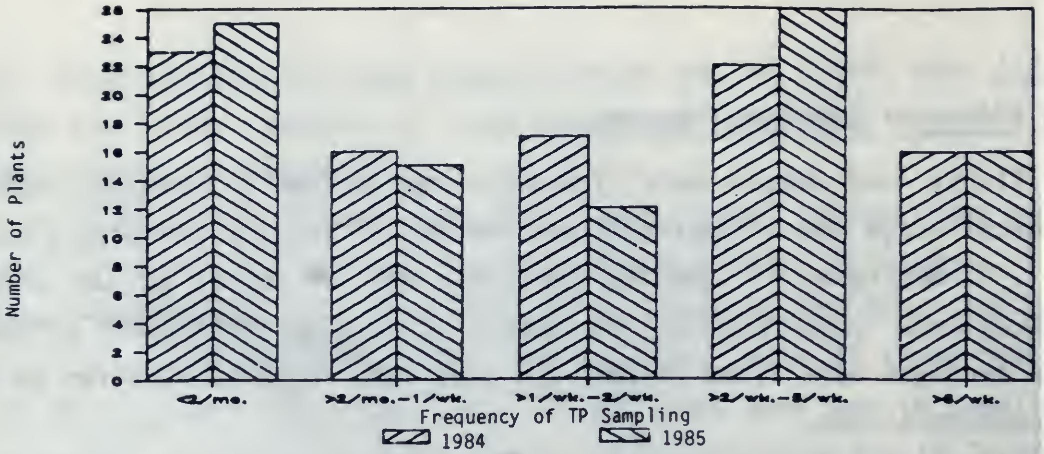

FIGURE 13 - SAMPLING FREQUENCIES FOR 96 PLANTS IN ONTARIO

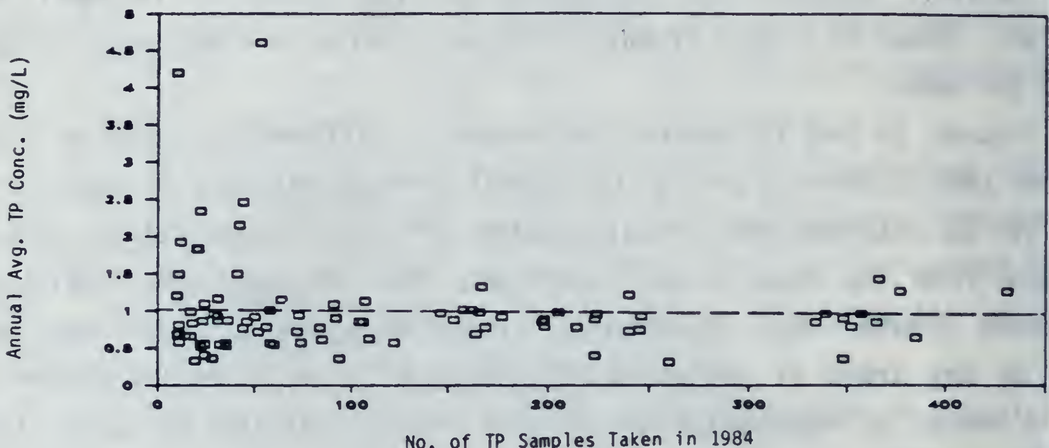

FIGURE 14 - SAMPLING FREQUENCY VS. 1984 ANNUAL AVERAGE EFFLUENT TP CONCENTRATION FOR 96 PLANTS IN ONTARIO

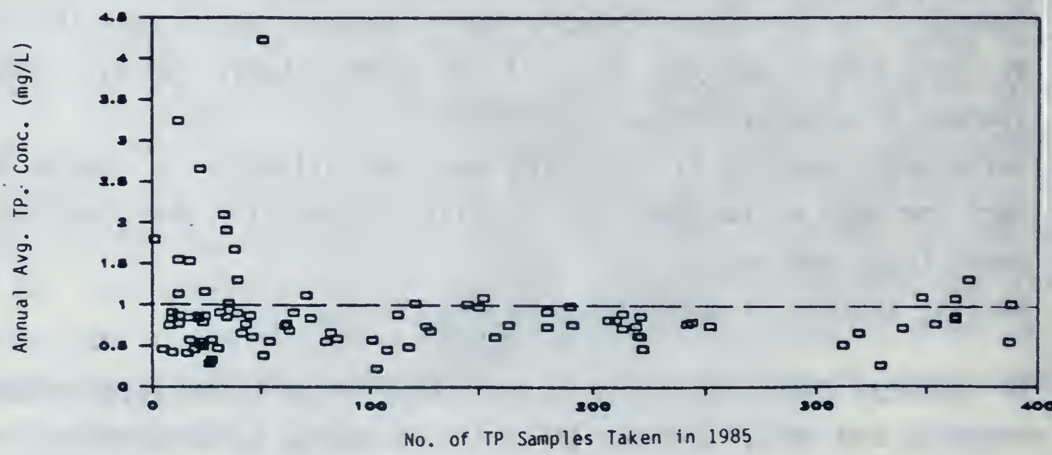

FIGURE 15 - SAMPLING FREQUENCY VS. 1985 ANNUAL AVERAGE EFFLUENT TP CONCENTRATION FOR 96 PLANTS IN ONTARIO

4.2 Plant Review

Information generated as a result of direct contact with the individual plants is summarized in Tables 29 to 31. Included in these summary tables are the 1984 and 1985 annual average effluent phosphorus concentrations, the number of months of TP compliance in these years, the chemical and dosage used for phosphorus removal and the reasons that were suggested for phosphorus removal performance. The most commonly suggested reasons for superior phosphorus removal performance were low clarifier surface loading, effluent polishing, polymer addition, and low influent P concentration. Reasons suggested most often for poor phosphorus removal performance included high clarifier surface loading, poor (or no) dosage control and low P removal chemical dosage. Due to the volume of information acquired from the 96 plants contacted in Phase 1, it is not considered practical to append this plant design and performance data.

Plants which were recommended for inclusion in the Phase 2 program were selected based on the performance and operating data acquired. Details of plant selection are discussed further in Section 7.0.

4.3 Summary of Key Findings

From the results of the historical data review, a number of key findings have been identified:

i) There was a general improvement in the number of plants that complied with BOD_5, TSS and TP effluent criteria from 1981 to 1985, indicating improved plant performance.

ii) There were significantly more plants that did not comply with TP requirements than with BOD_5 and TSS in all years.

iii) A comparison of an 'annual average' method to a 'monthly average' method of assessing compliance shows that a larger percentage of plants are not in compliance based on the monthly average criterion. The largest increase is associated with compliance with effluent TP requirements.

iv) Based on the 'annual average' method of measuring compliance, a total of 18 plants would require improvements in their phosphorus removal performance based on 1985 data. This compares to a total of 63 plants which would require improvements to meet the monthly average compliance requirements for total phosphorus.

TABLE 29. SUMMARY OF PLANT PHOSPHORUS REMOVAL PERFORMANCE AND METHODS FOR LAKE ERIE DRAINAGE BASIN

PLANT	AVERAGE EFFLUENT TP (mg/L)		NUMBER OF MONTHS TP > 1 mg/L		CHEMICAL USED FOR P-REMOVAL	DOSAGE mg Metal/L		METAL:TP MOLAR RATIO		COMMENTS RANK - MOST IMPORTANT		
	1984	1985	1984	1985		1984	1985	1984	1985	1.	2.	3.
Amherstburg WPCP	4.2	3.25	10/10	10	$FeCl_3$	8.1	15.0	0.95:1	1.6:1	Inadequate plant capacity	Operator problems	Higher than avg. chemical required
Brantford WPCP	0.74	0.75	0	1	$FeCl_2$	9.4	8.6	1.0:1	0.9:1	Adequate chemical dosage		
Galt WPCP (Cambridge)	0.89	0.80	2	0	$FeCl_3$	4.9	6.3	0.5:1	0.5:1	Good sludge settleability		
Hespeler WPCP (Cambridge)	0.92	1.27	4	7	$FeCl_3$/$FeCl_3$ 50/50	7.7	7.7	1.2:1	0.7:1	High clarifier surface loading	Poor dosage control	Poor sludge settleability
Preston WPCP (Cambridge)	0.57	0.75	0	3/11	$FeCl_3$	4.9	5.4	0.4:1	0.46:1	Low clarifier surface loading	Good sludge settleability	Good dosage control
Chatham WPCP	0.78	0.99	0	6	$FeCl_2$	10.8	9.3	0.42:1	0.28:1	Effluent polishing ponds	Low clarifier surface loading	Superior plant operation
Dresden WPCP	0.55	0.39	3	0	Alum (-'85) Poly Alum Chloride ('86)	3.9	5.0	1.0:1	1.23:1	Low clarifier surface loading	High chemical dosage	Separate sewers
Dunnville WPCP	1.02	0.60	3	0	$FeCl_2$	2.6	2.5	0.39:1	0.36:1	Low clarifier surface loading	Good sludge settleability	Bypassing during peak infiltration
Fergus WPCP	0.64	0.59	0	0								
Guelph WPCP	0.96	0.82	6	3	Alum	6.5	6.5	1.14:1	1.16:1	Effluent filtration	High chemical dosage	Superior plant operation
Ingersoll New WPCP	0.52	0.81	2	2	$FeCl_3$	6.0	7.3	0.44:1	0.59:1	Poor dosage control	Infiltration/inflow	
Kitchener WPCP	0.69	0.76	0	0	$FeSO_4$	7.7	9.3	0.6:1	0.75:1	Good dosage control	Low clarifier surface loading	Superior plant operation
Leamington WPCP	0.58	0.93	2	4	$FeCl_3$	4.4	1.6	1.34:1	0.53:1			
Adelaide WPCP (London)	0.93	0.86	2	0	$FeCl_2$	--	9.0	--	0.63:1			
Greenway WPCP (London)	0.93	0.78	4	2	$FeCl_2$	--	3.24	--	0.3:1			
Oxford WPCP (London)	0.88	0.74	3	0	$FeCl_2$	--	17.7	--	1.3:1	High chemical dosage	Low clarifier surface loading	
Pottersburg WPCP (London)	0.85	0.65	0	1	$FeCl_2$	--	6.1	--	0.65:1	Industrial waste factors	Low clarifier surface loading	High chemical dosage
Vauxhall WPCP (London)	0.79	0.62	1	1	Lime	--	42.0	--	--	Industrial waste factors	Low clarifier surface loading	
Belle River-Maidstone WPCP	0.62	0.84	2	3	Alum	3.02	2.26	1.27:1	0.82:1	Low clarifier surface loading	Low influent P concentration	
Corunna P.V. Plant (Moore)	0.87	0.84	7	5	Alum	7.32	7.79	1.32:1	1.14:1	Low clarifier surface loading	No industrial waste factors	
Paris WPCP	0.58	0.55	0	1	$FeCl_3$	27.0	24.0	2.1:1	1.4:1	Only 35% design capacity	High chemical dosage	
Sarnia WPCP	0.78	0.83	0	1	$FeCl_3$/Polymer in summer	7.2	7.2	0.74:1	0.75:1	Low clarifier surface loading	Polymer addition	
Simcoe WPCP	0.79	0.71	1	0	$FeCl_3$	10.0	8.3	0.8:1	0.68:1	Effluent polishing/filtration	Low clarifier surface loading	Low peak flow/variable pump speeds
St. Thomas WPCP	1.20	1.12	6/11	5	Alum	4.3	4.3	1.12:1	0.94:1	Point of chemical addition	Complex plant operation	Low P removal chemical dosage
Stratford WPCP	0.56	0.23	0	0	Alum/$FeCl_2$	(Al)	4(Fe)	--	0.53:1	Effluent filtration	High chemical dosage	
Tillsonburg WPCP	0.40	0.78	0	1	Alum	4.0	3.3	0.85:1	0.63:1	Low clarifier surface loading	Industrial waste factors	Good sludge settleability
Wallaceburg WPCP	0.67	0.42	2	1/9	$FeCl_3$	9.5	5.9	1.24:1	0.74:1	High chemical dosage	Good plant operation	
Waterloo WPCP	0.98	0.74	4	1	$FeCl_2$	5.3	6.2	0.44:1	0.53:1	Low clarifier surface loading	Good dosage control	Good sludge settleability
Little R. WPCP (Windsor)	1.22	0.81	5	4	$AlCl_3$	7.8	6.6	1.6:1	1.6:1	Adequate chemical dosage	Satisfactory plant performance	
Westerly WPCP (Windsor)	0.73	0.85	1	2	$FeCl_3$ ('84) Alum ('85)	1.57	3.3	1.7:1	0.85:1	Presently using $AlCl_3$ (1986)	Adequate chemical dosage	Good plant operation
Woodstock WPCP	0.95	1.02	3	5/11	$FeCl_3$	6.06	5.4	0.79:1	0.83:1	Poor dosage control		

TABLE 30. SUMMARY OF PLANT PHOS HORUS REMOVAL PERFORMANCE AND METHODS FOR LAKE ONTARIO DRAINGAGE BASIN

PLANT	AVERAGE EFFLUENT TP (mg/L)		NUMBER OF MONTHS TP > 1 mg/L		CHEMICAL USED FOR P-REMOVAL	DOSAGE mg Metal/L		METAL:TP MOLAR RATIO		COMMENTS		
										RANK - MOST IMPORTANT		
	1984	1985	1984	1985		1984	1985	1984	1985	1.	2.	3.
Belleville WPCP	1.02	0.49	4	0	$FeCl_3/FeCl_2$	9.1	9.1	1.1:1	1.4:1	Present dosage 15 mg/L Fe^{3+}	Under construction until 1985	
Brockville WPCP	1.01	0.87	6	3	$FeCl_3$	9.1	10.2	1.13:1	1.4:1	High chemical dosage	Low influent P concentration	Good dosage control
Skyway WPCP (Burlington)	0.72	0.79	1	1	$FeCl_3$	3.7	3.8	0.26:1	0.31:1	Good sludge settleability	Low clarifier surface loading	Superior Plant operation
Campbellford WPCP	0.69	0.86	1/11	3	No chemicals used.	--	--	--	--	Low influent P concentration		
Cobourg WPCP No. 1	0.66	1.62	2	3/10	No chemicals used.	--	--	--	--	No chemicals added		
Cornwall WPCP	0.98	0.97	4	6	Alum/polymer	4.7	4.8	2:17	2:1:1	Polymer addition	Low influent P concentration	High chemical dosage
Dundas WPCP	0.78	0.82	3	4	Alum	3.2	3.7	0.64:1	0.72:1	Low clarifier surface loading	Good sludge settleability	High chemical dosage
Anger Ave. WPCP (Fort Erie)	0.77	0.73	2	2	$FeCl_3$	10	11	1.9:1	1.7:1	High chemical dosage	Industrial waste factors	Low clarifier surface loading
Baker Rd. WPCP (Grimsby)	0.72	0.60	1/11	0	$FeSO_4$	5.7	9.8	--	1.0:1	Low clarifier surface loading	High chemical dosage	Good sludge settleability
Acton WPCP + Lagoon (Halton Hills)	0.55	0.57	2	1	$FeCl_3$	12.9	12.7	1.0:1	1.3:1	Effluent filtration	Tertiary ponds	High chemical dosage
Georgetown WPCP (Halton Hills)	1.16	0.50	5	0	$FeCl_3$	12.4	13.7	0.54:1	0.74:1	Effluent filtration	High chemical dosage	Low clarifier surface loading
Woodward Ave. WPCP (Hamilton)	1.27	1.30	6	9	No chemicals used.	--	--	--	--	No chemicals added		
Iroquois WPCP	2.15	--	6/8	--	$FeCl_3$	21.4	17.5	0.4:1	--	SS carry-over	Low chemical dosage	
Kingston WPCP	0.96	0.88	2	0	$FeCl_3$	8.1	7.1	1.3:1	0.9:1	High chemical dosage	Low influent P concentration	
Kingston TWP WPCP	0.91	0.76	4	1	Alum	--	5.1	--	0.93:1	Superior plant operation	Good dosage control	Low clarifier surface loading
Highland Creek WPCP (Metro Toronto)	0.91	0.77	2	0	$FeCl_2$	6.1	7.5	0.60:1	0.75:1	Adequate chemical dosage		
Humber WPCP (Metro Toronto)	1.43	1.06	10	6	$FeCl_2$	6.3	7.2	0.35:1	0.45:1	Sludge management problems	Low chemical dosage	
Main WPCP (Metro Toronto)	0.97	1.08	4	6	$FeCl_2$	7.5	8.5	0.71:1	0.81:1	Adequate chemical dosage		
North Toronto WPCP (Metro Toronto)	0.85	0.85	3	2	$FeCl_2$	9.1	7.8	0.95:1	0.85:1	Adequate chemical dosage		
Milton WPCP	0.36	0.27	0/10	0/10	Alum	9.0	9.6	1.62:1	1.17:1	Effluent filtration	High chemical dosage	
Clarkson WPCP (Mississauga)	0.89	0.91	1	2	$FeCl_2$	11.6	12.6	0.8:1	0.87:1	Good dosage control	Low clarifier surface loading	Good sludge settleability
Lakeview WPCP (Mississauga)	0.85	0.65	2	0	$FeCl_2$	9.26	11.7	0.25:1	0.75:1	Good dosage control		
Napanee WPCP	2.46	1.41	11	9	$FeCl_2$	19.4	24.5	0.85:1	1.02:1	Industrial waste factors	Poor sludge settleability	High influent P concentration
Port Darlington WPCP (Newcastle)	1.83	0.93	6/10	3/11	Alum	1.91	1.85	0.4:1	0.32:1	Low chemical dosage		
Stamford WPCP (Niagara Falls)	0.63	0.45	1	0	$FeCl_3$	18.8	18.5	2:4:1	3:1:1	High chemical dosage	Low clarifier surface loading	Good dosage control
South East WPCP (Oakville)	0.87	0.85	4	4/11	Alum	4.8	8.1	0.7:1	0.98:1	Low clarifier surface loading	Good sludge settleability	Good dosage control
South West WPCP (Oakville)	0.93	0.89	4	4/11	$FeCl_3$	14.9	8.9	0.96:1	0.6:1	Poor sludge settleability	Industrial waste factors	Infiltration/combined flow
Orangeville WPCP	0.36	0.25	0	0	Alum	6.7	6.3	1.5:1	1.14:1	Effluent polishing	Good sludge settleability	Low clarifier surface loading
Harmony Cr. 1 WPCP (Oshawa)	1.02	0.58	6	1/6	Alum	--	22.9	--	4.2:1	High chemical dosage	Low clarifier surface loading	Industrial waste factors
Harmony Cr. 2 WPCP (Oshawa)	1.02	0.58	3	0/4	Alum	--	14.5	--	2.6:1	High chemical dosage	Low clarifier surface loading	
Peterborough WPCP	0.81	0.80	4	3/11	$FeSO_4$	3.3	3.1	0.6:1	0.53:1			
York Durham WPCP (Pickering)	0.98	1.05	4	5	Alum	4.4	5.0	0.7:1	0.95:1	Low chemical dosage		
Picton WPCP	0.68	0.50	7	1	Alum	3.4	4.0	--	1.8:1	High chemical dosage	Good dosage control	
Seaway WPCP (Port Colborne)	1.15	1.05	0	6	$FeCl_3$	8.0	10.3	0.63:1	0.48:1	High influent P concentration	Industrial waste factors	Sludge management problems
Port Hope WPCP	0.53	0.57	1	0/11	Alum	2.8	2.8	1.0:1	1.7:1	Low influent P concentration	Superior plant operation	Good dosage control
Prescott-Edwardsburgh WPCP	0.88	0.62	1	0	$FeCl_3$/Polymer	8.3	7.0	0.9:1	0.9:1	Polymer addition	High chemical dosage	Good dosage control
Port Dalhousie WPCP (St. Catharines)	0.55	0.39	0	0	$FeCl_3$	13.3	11.2	1.15:1	0.9:1	Low clarifier surface loading	High chemical dosage	Low influent P concentration
Port Weller WPCP (St. Catharines)	0.57	0.76	0	2	Alum	5.0	4.0	1.1:1	0.82:1	Good sludge settleability	Low clarifier surface loading	High chemical dosage
Trenton WPCP	0.58	0.66	1	0	$FeCl_2$	15.0	10.4	1.4:1	0.9:1	High chemical dosage	Low clarifier surface loading	
Welland WPCP	0.73	0.72	0	2	$FeCl_2$	2.7	3.7	0.22:1	0.58:1	Low clarifier surface loading	Good sludge settleability	
Corbett Cr. WPCP (Whitby)	0.85	0.59	3	0	Alum	7.1	6.05	1.7:1	1.4:1	Low clarifier surface loading	High chemical dosage	
Pringle Cr. WPCP No. 1 (Whitby)	0.90	0.70	3	2	Alum	4.0	4.2	1.2:1	1.8:1	Low influent P concentration	High chemical dosage	
Pringle Cr. WPCP No. 2 (Whitby)	1.09	0.94	4	5	Alum	4.37	3.05	1.33:1	1.28:1	Low influent P	Low clarifier surface loading	

TABLE 31. SUMMARY OF PLANT PHOSPHORUS REMOVAL PERFORMANCE AND METHODS FOR UPPER GREAT LAKES DRAINAGE BASIN

PLANT	AVERAGE EFFLUENT TP (mg/L)		NUMBER OF MONTHS TP > 1 mg/L		CHEMICAL USED FOR P-REMOVAL	DOSAGE mg Metal/L		METAL:TP RATIO		COMMENTS RANK - MOST IMPORTANT		
	1984	1985	1984	1985		1984	1985	1984	1985	1.	2.	3.
Barrie WPCP	0.96	0.50	4	0	Alum	5.0	5.0	0.68:1	0.58:1	Superior plant operation	Low clarifier surface loading	
Bradford WPCP	0.87	0.41	0	0	Alum	6.3	6.7	0.83:1	1.1:1	Effluent filtration	Polymer addition	Low clarifier surface loading
Collingwood WPCP	1.53	1.89	8/11	10	Alum	2.9	3.8	0.38:1	0.39:1	High clarifier surface loading	High influent P concentration	Sludge management problems
Esten Lake WPCP (Elliot Lake)	1.35	1.10	6	7	Alum							
Goderich WPCP	1.13	0.90	8	3	Alum	--	1.89	--	0.5:1	High clarifier surface loading	Infiltration/inflow	
Hanover WPCP	0.88	0.87	4	3	Alum	4.6	4.2	0.82:1	0.60:1	Low clarifier surface loading	Good dosage control	Superior plant operation
Huntsville WPCP	0.32	0.76	0	2/7	Alum							
Midland WPCP	0.57	0.57	1/11	0	$FeCl_3$	7.3	5.1	0.82:1	0.64:1	Low influent P concentration	High chemical dosage	Low clarifier surface loading
North Bay WPCP	1.49	1.67	10	12	$FeCl_3/FeCl_2$ 50/50	20	20	0.76:1	1.2:1	Infiltration/inflow	Poor dosage control	Construction
Orillia WPCP	0.40	0 58	0	3	Alum	3.9	3.1	2.1:1	1.13:1	Low influent P concentration	High chemical dosage	Industrial waste factors
Owen Sound WPCP	0.83	0.85	2	3	$FeCl_3$	8.0	7.9	1.05:1	0.9:1	Adequate chemical dosage		
Parry Sound WPCP	0.79	0.53	5	0	$FeCl_3$	3.8	4.5	0.53:1	0.82:1	Low clarifier surface loading	Good sludge settleability	Good dosage control
Port Elgin WPCP	1.87	1.45	11	11	Installed in 1986	--	--	--	--	No chemicals added		
Sault Ste. Marie WPCP	4.74	4.01	12	12	No chemicals used	--	--	--	--	No chemicals added		
Sturgeon Falls WPCP	0.32	0.41	0	0/10	$FeCl_2/FeCl_3$ 50/50	3.3	3.9	0.62:1	0.63:1	No industrial wastes	Low influent P concentration	Superior plant operation
Sudbury WPCP	1.82	2.07	12	12	Installed in 1986	--	--	--	--	No chemicals added		
Thunder Bay WPCP	1.25	0.94	10	4	$FeCl_3$	17.3	15.8	2.5:1	2.5:1	High clarifier surface loading		
Hamner, Val-Caron, Val-Therese WPCP (Valley East)	1.11	0.68	5	0	$FeCl_2/FeCl_3$ 50/50	10.3	8.4	1:1	0.89:1			
Mikkola WPCP (Walden)	2.34	2.56	12	12	No chemicals used	--	--	--	--	No chemicals added		
Walkerton WPCP	0.98	0.94	4	5	Alum (to 1985) $FeCl_3$ (1985-)	--	6.7	--	0.4:1	Low clarifier surface loading	Good dosage control	Superior plant operation
Wasaga Beach WPCP	--	--	--	--	--	--	--	--	--	No chemical addition		

5.0 LOADINGS TO THE GREAT LAKES BASINS

Total flows from municipal treatment facilities larger than 4546 m^3/d, total phosphorus loadings and aggregate average phosphorus concentrations were calculated for 1981 to 1985 for each drainage basin (Lake Erie, Lake Ontario, Lake Huron and Lake Superior) using the methodologies described in Section 3.3. Individual plant loadings for 1984 and 1985 are shown in Tables A1 to A3, Appendix A. Table 32 summarizes these parameters for all basins for 1981 to 1985. Based on the historical data, flows and phosphorus loadings to each basin were projected for 1986 to 1990. As described in Section 3.3, flow projections were based on linear regession of the historical flow data for each basin for the time period 1981 to 1985, and were compared to the total basin WPCP design flow capacity. As basin flows increase, the corresponding increase in hydraulic loading at individual plants may cause deterioration in phosphorus removal efficiencies. Evaluation of the present and projected flows that will exceed individual plant design capacity gives an indication of when effluent phosphorus quality will begin to deteriorate at individual plants if design capacities are not increased. The total basin phosphorus loadings from 1986 to 1990 were calculated based on the projected flows to each basin assuming 1985 effluent quality is maintained. The limitation of this assumption should be noted. The probable impact of increased flows on plant capability to maintain the present (1985) level of treatment, and resulting effect on total basin loadings, was not considered.

5.1 Lake Erie Basin

Actual and projected flows from treatment plants under consideration in the Lake Erie Basin are presented in Figure 16. Based on linear regression, the flow to Lake Erie from these plants has increased at an average rate of 2.5 percent per year for the period from 1981 to 1985. In 1985, 18.0 percent of the total basin flows were from 4 plants which had exceeded design capacity. This is predicted to increase to 39.9 percent in 1990, as a result of 11 plants exceeding design capacity. The total basin WPCP design flow capacity will be exceeded in 1991 if no expansions occur in the meantime.

The total phosphorus loading over the period from 1981 to 1985 has averaged 239.3 tonnes per year, with no apparent trend as indicated in Figure 17. The annual loading increase projected based on 1985 effluent quality and a 2.5 percent per year flow increase is also shown in Figure 17.

TABLE 32. SUMMARY OF BASIN FLOWS, PHOSPHORUS LOADINGS, AND AGGREGATE AVERAGE PHOSPHORUS CONCENTRATIONS

BASIN	PARAMETER	YEAR				
		1981	1982	1983	1984	1985
LAKE ERIE	Flow (1000 m^3/d)	701.65	741.95	761.96	772.03	841.37
	Loading (tonnes/yr)	229.42	250.74	246.85	222.55	247.07
	Agg. Avg. TP (mg/L)	0.90	0.93	0.89	0.79	0.80
LAKE ONTARIO/ ST. LAWRENCE	Flow (1000 m^3/d)	2584.09	2653.95	2702.66	2687.59	2795.14
	TP Loading (tonnes/yr)	1071.69	1026.61	949.45	979.08	950.06
	Agg. Avg. TP (mg/L)	1.14	1.06	0.96	1.00	0.93
LAKE HURON	Flow (1000 m^3/d)	260.80	272.46	272.54	281.65	302.69
	TP Loading (tonnes/yr)	211.14	152.03	163.05	183.60	189.88
	Agg. Avg. TP (mg/L)	2.22	1.53	1.64	1.79	1.72
LAKE SUPERIOR	Flow (1000 m^3/d)	81.74	96.83	100.61	104.23	113.95
	TP Loading (tonnes/yr)	93.68	109.56	55.23	47.64	38.95
	Agg. Avg. TP (mg/L)	3.14	3.10	1.50	1.25	0.94

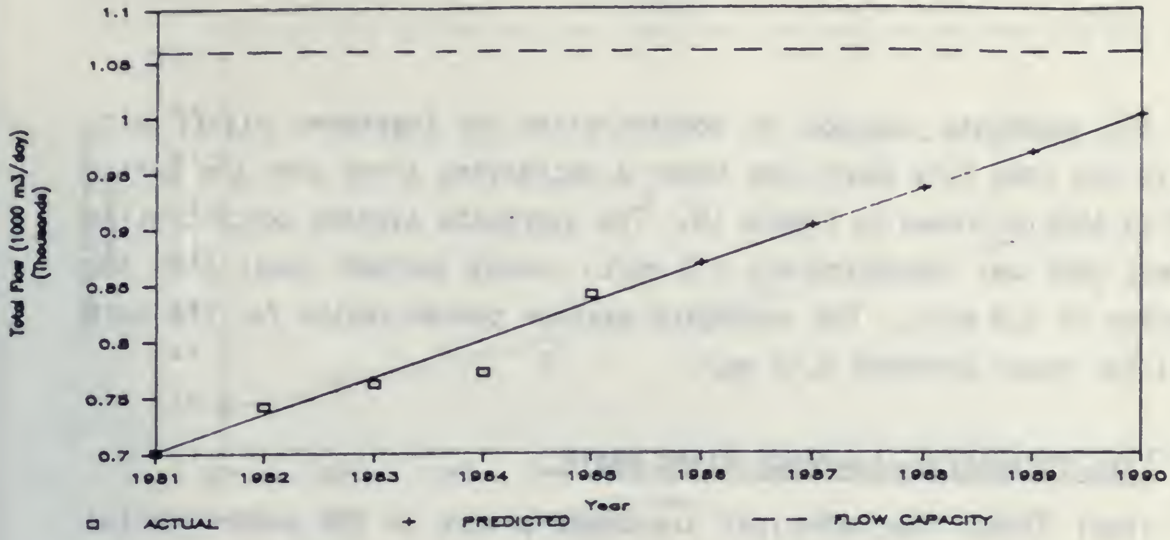

FIGURE 16 - LAKE ERIE DRAINAGE BASIN - TOTAL FLOW VS. TIME

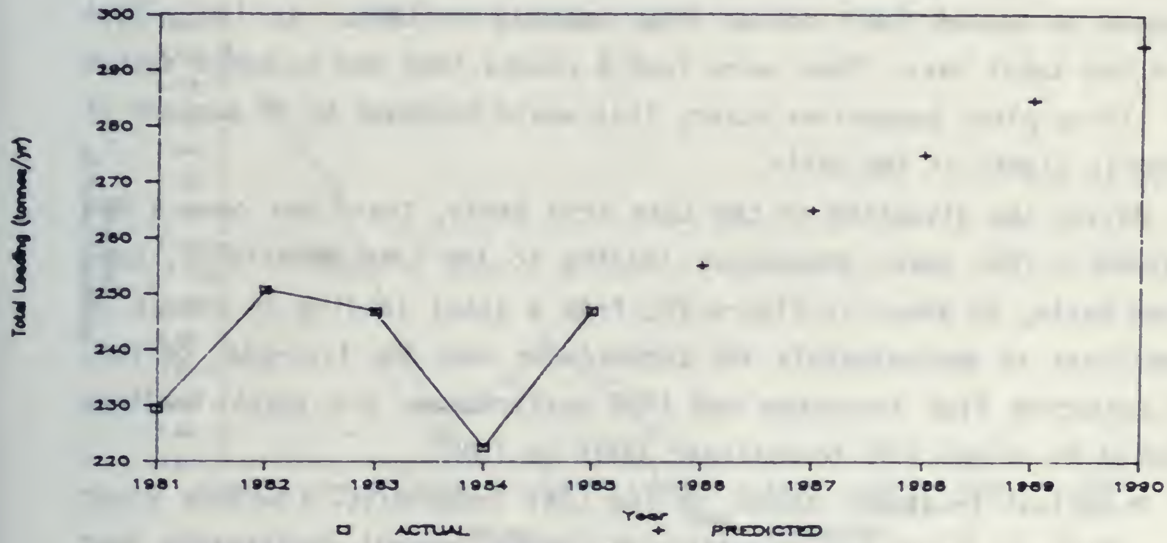

FIGURE 17 - LAKE ERIE DRAINAGE BASIN - TOTAL PHOSPHORUS LOADING VS. TIME

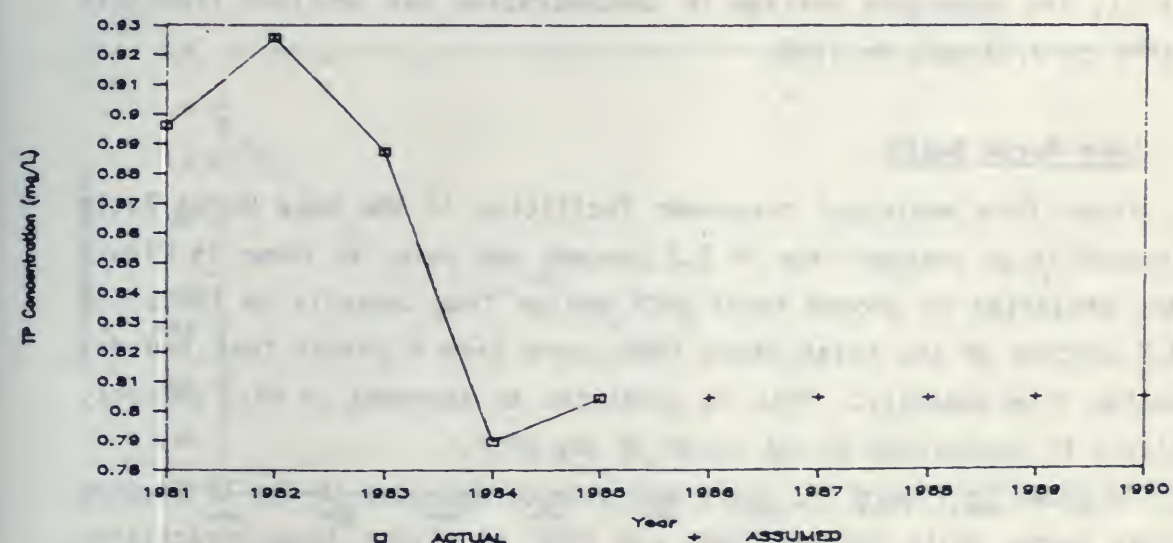

FIGURE 18 - LAKE ERIE DRAINAGE BASIN - AGGREGATE AVERAGE TP CONCENTRATION VS. TIME

The aggregate average TP concentration in treatment plants discharging to the Lake Erie Basin has shown a decreasing trend over the period from 1981 to 1985 as shown in Figure 18. The aggregate average concentration in 1984 and 1985 was approximately 0.8 mg/L, twenty percent lower than the IJC objective of 1.0 mg/L. The aggregate average concentration for the past five years has never exceeded 0.93 mg/L.

5.2 Lake Ontario/St. Lawrence River Basin

Total flows from municipal treatment plants in the Lake Ontario/St. Lawrence River Basin have increased at a rate of approximately 1.7 percent per year over the period from 1981 to 1985, as shown in Figure 19 and are projected to exceed basin design flow capacity in 1997. In 1985, 12.4 percent of the total basin flows were from 8 plants that had exceeded design capacity. If no plant expansions occur, this would increase to 28 percent of flows, from 11 plants in the basin.

Unlike the situation in the Lake Erie Basin, there has been a declining trend in the total phosphorus loading to the Lake Ontario/St. Lawrence River Basin, as shown in Figure 20, from a total loading in excess of 1000 tonnes/year to approximately 950 tonnes/year over the five-year period. Based on projected flow increases and 1985 performance, the total loadings are projected to exceed 1000 tonnes/year again by 1989.

Municipal treatment plants in the Lake Ontario/St. Lawrence River have shown the same trend toward better phosphorus removal performance over the time period from 1981 to 1985 as plants in the Lake Erie basin. As shown in Figure 21, the aggregate average TP concentration has declined from 1.14 mg/L in 1981 to 0.93 mg/L in 1985.

5.3 Lake Huron Basin

Flows from municipal treatment facilities in the Lake Huron Basin have increased at an average rate of 3.2 percent per year, as shown in Figure 22 and are projected to exceed total WPCP design flow capacity in 1986. In 1985, 23.3 percent of the total basin flows were from 4 plants that had exceeded design flow capacity. This is predicted to increase to 64.0 percent, from 9 plants if expansions do not occur at any WPCP.

As shown in Figure 23, there was a major decrease in the TP loading to the Lake Huron Basin between 1981 and 1982 as plants began practising

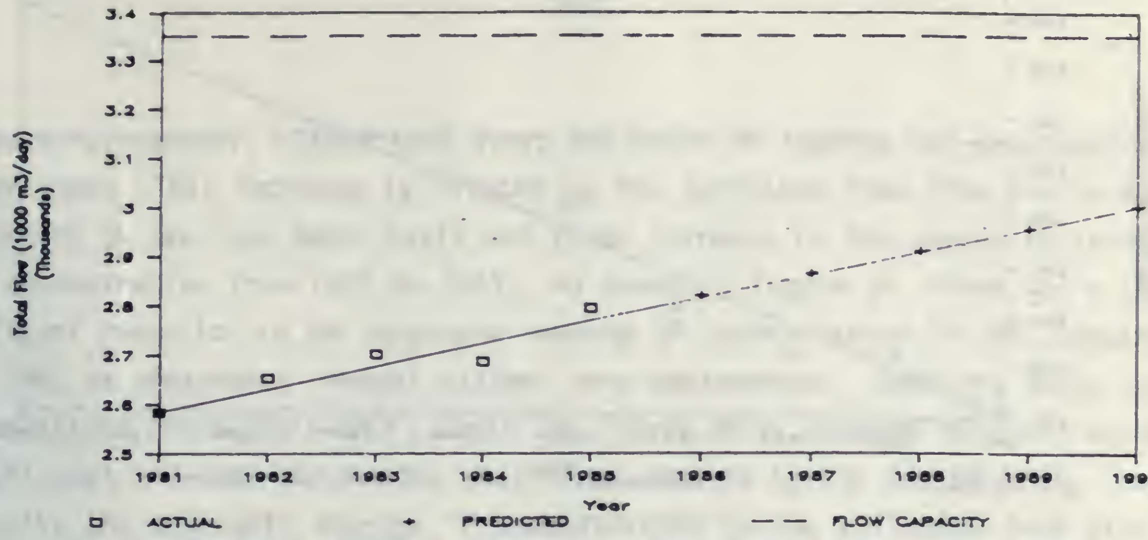

FIGURE 19 - LAKE ONTARIO DRAINAGE BASIN - TOTAL FLOW VS. TIME

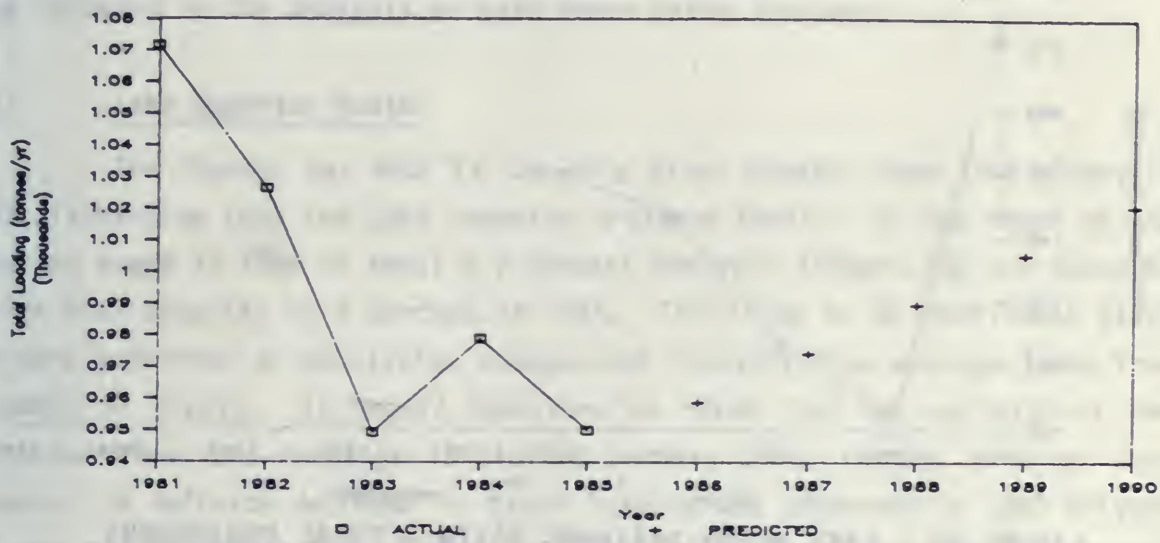

FIGURE 20 - LAKE ONTARIO DRAINAGE BASIN - TOTAL PHOSPHORUS LOADING VS. TIME

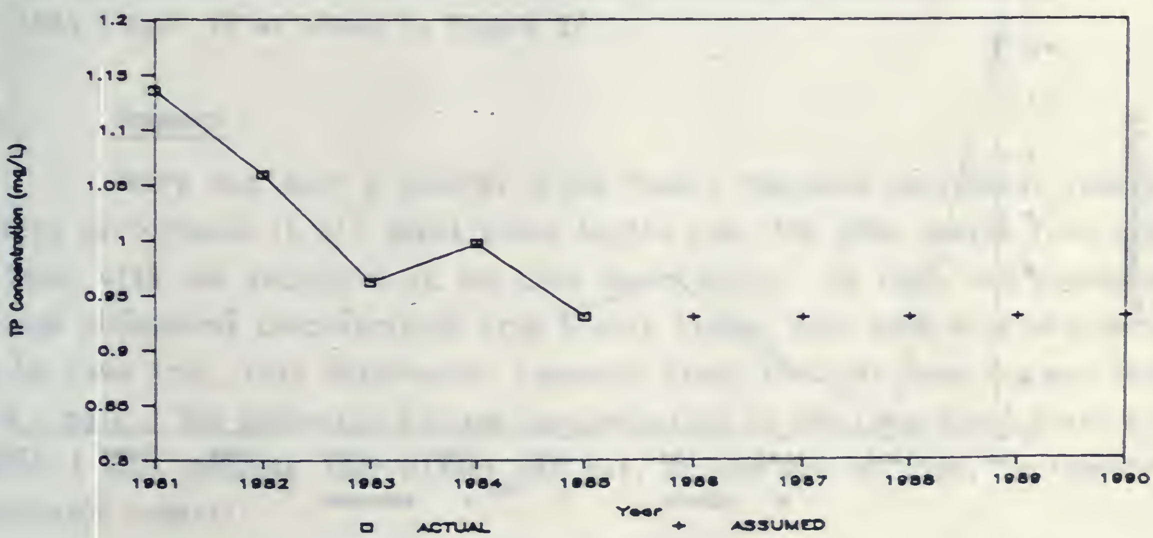

FIGURE 21 - LAKE ONTARIO DRAINAGE BASIN - AGGREGATE AVERAGE TP CONCENTRATION VS. TIME

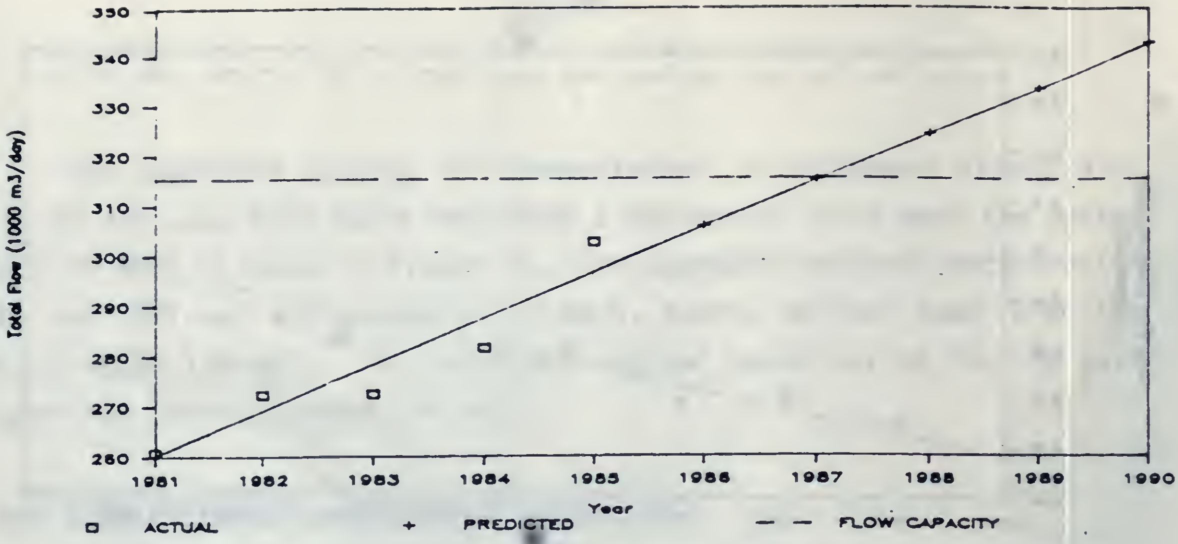

FIGURE 22 - LAKE HURON DRAINAGE BASIN - TOTAL FLOW VS. TIME

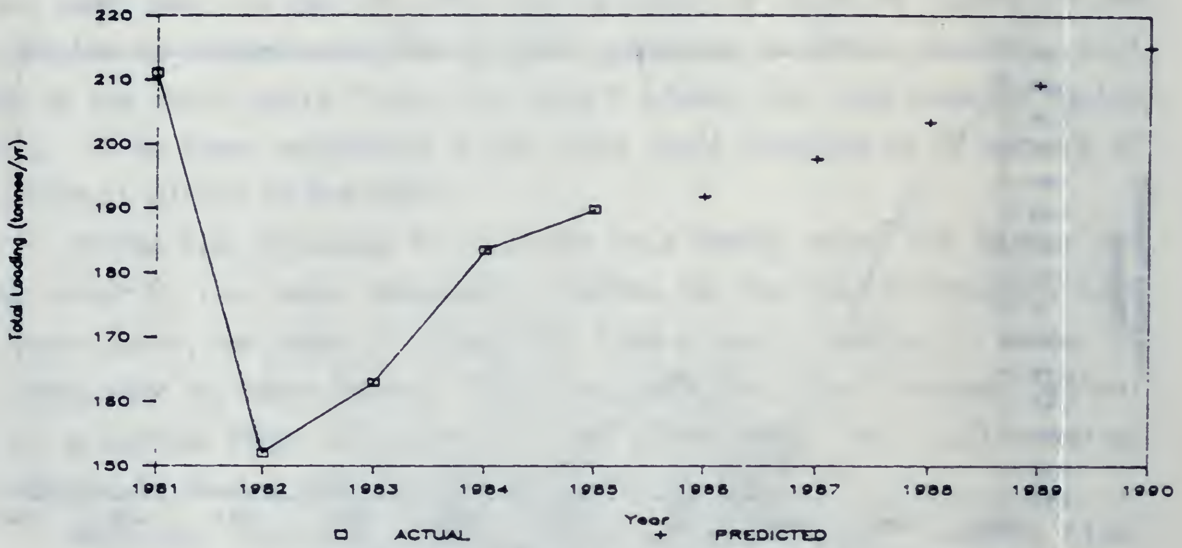

FIGURE 23 - LAKE HURON DRAINAGE BASIN - TOTAL PHOSPHORUS LOADING VS. TIME

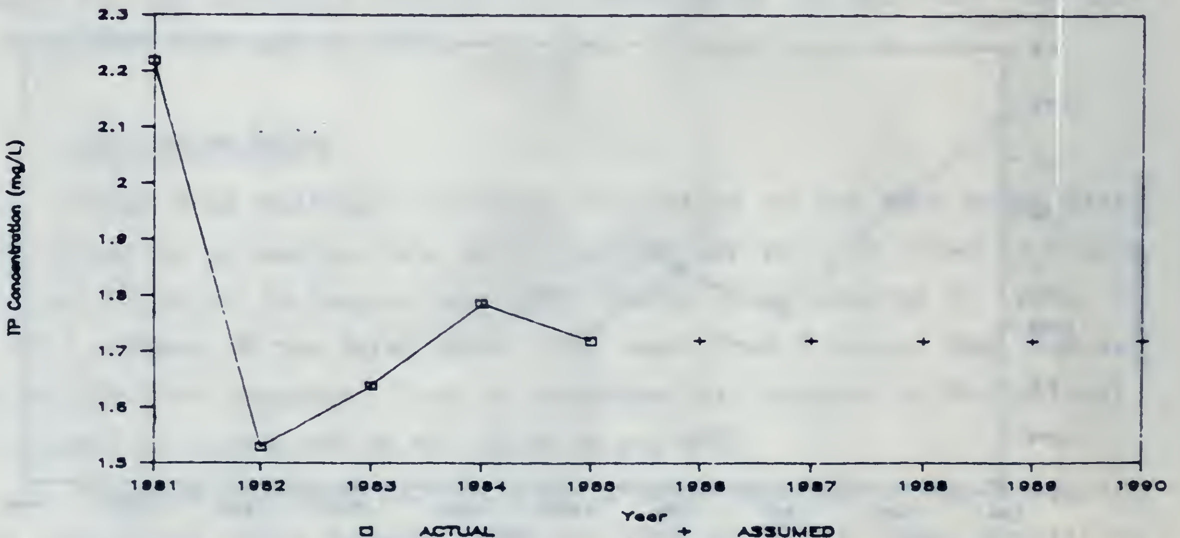

FIGURE 24 - LAKE HURON DRAINAGE BASIN - AGGREGATE AVERAGE TP CONCENTRATION VS. TIME

phosphorus removal. Since that time, the basin TP loading has progressively increased. This increase is related to the increased flow from plants discharging to the Lake Huron Basin and to an increase in the aggregate average TP concentration from 1982 to 1985. As shown in Figure 24, there was a significant reduction in the aggregate average TP concentration in 1982 compared to 1981 as phosphorus removal systems were implemented. However, there were four plants (Port Elgin WPCP, Sault Ste. Marie WPCP, Sudbury WPCP and Walden WPCP) that had not implemented phosphorus removal by the end of 1985. As a result, the aggregate average TP concentration in the effluents from plants in the Lake Huron Basin has consistently exceeded 1 mg/L. It should be noted that Wasaga Beach WPCP, which is classified as an exfiltration plant, has not been included in the analysis of Lake Huron Basin loadings.

5.4 Lake Superior Basin

The Thunder Bay WPCP is the only plant greater than 4546 m^3/day (1 MGD) discharging into the Lake Superior drainage basin. It has shown an increasing trend in flow of about 6.7 percent per year (Figure 25) and exceeded design flow capacity by 4 percent in 1985. The flows to an individual plant are more sensitive to population changes and industry than average flows from a number of plants. It should therefore be noted that the validity of the projected flows and loadings is limited because these factors were not considered. A definite decrease in basin loading was observed in 1983 (Figure 26) due to implementation of phosphous removal processes at the Thunder Bay WPCP. Performance of the phosphorus removal system at Thunder Bay have progressively improved since implementation. In 1985, effluent quality was better than 1 mg/L TP as shown in Figure 27.

5.5 Summary

There has been a general trend toward improved phosphorus removal process performance in all Great Lakes basins over the time period from 1981 to 1985, with the exception of the Lake Huron Basin. In 1985, the aggregate average phosphorus concentration from plants larger than 4546 m^3/d discharging to Lake Erie, Lake Ontario/St. Lawrence River and Lake Superior was less than 1 mg/L. The aggregate average concentration in the Lake Huron Basin exceeded 1 mg/L because four plants had not, by the end of 1985, implemented phosphorus removal.

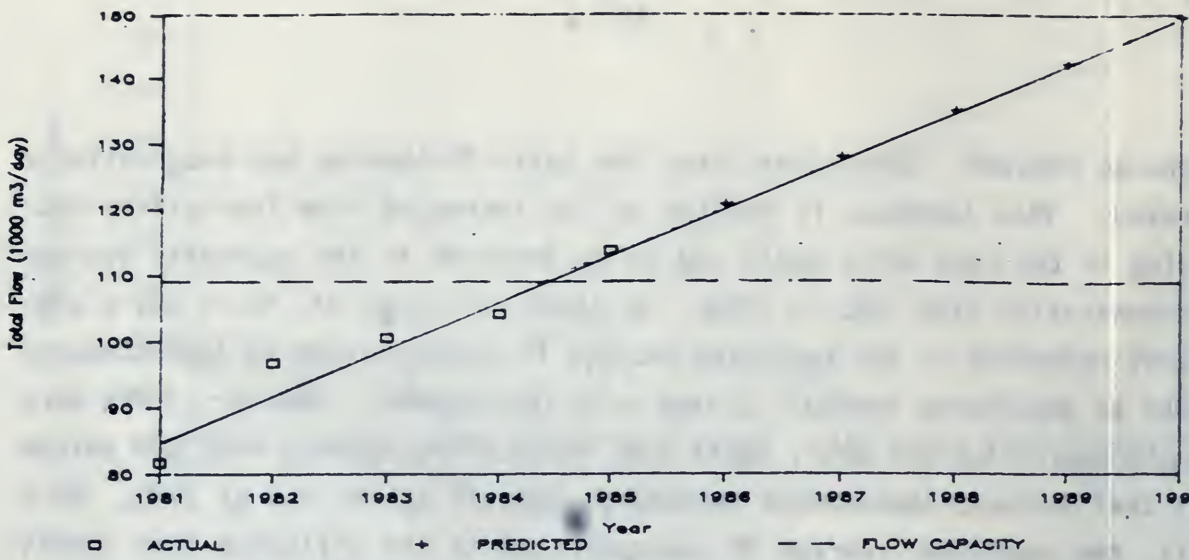

FIGURE 25 - LAKE SUPERIOR DRAINAGE BASIN - TOTAL FLOW VS. TIME

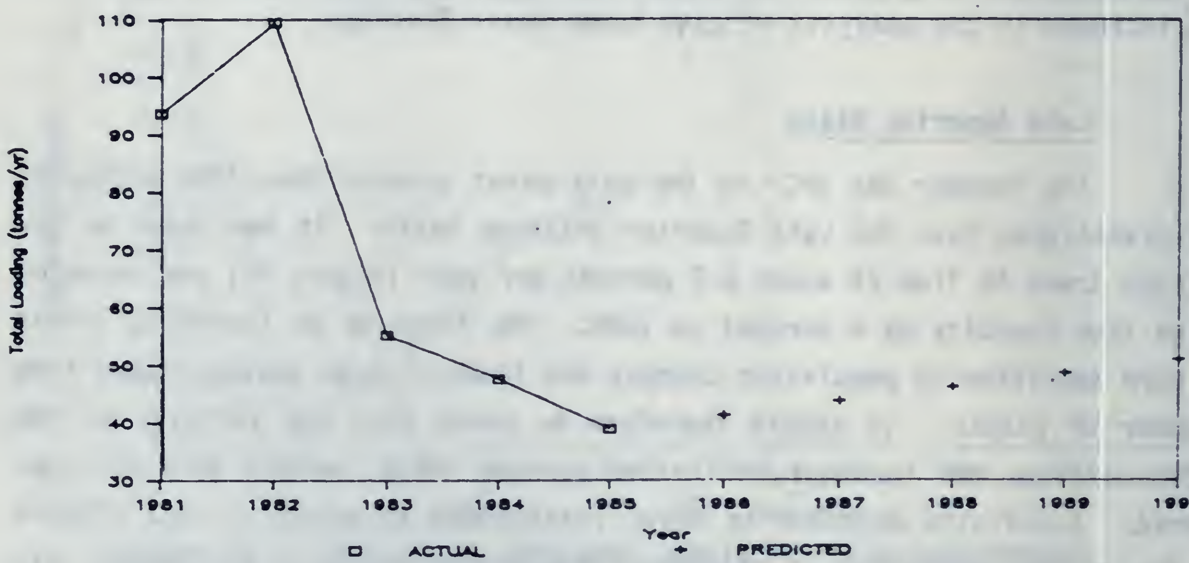

FIGURE 26 - LAKE SUPERIOR DRAINAGE BASIN - TOTAL PHOSPHORUS LOADING VS. TIME

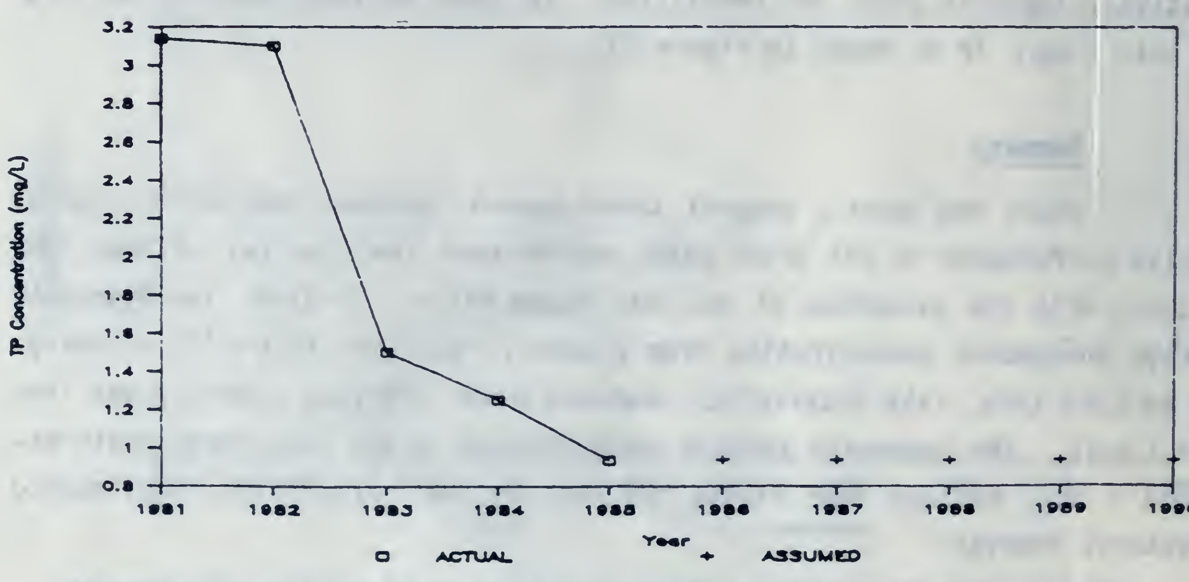

FIGURE 27 - LAKE SUPERIOR DRAINAGE BASIN - AGGREGATE AVERAGE TP CONCENTRATION VS. TIME

Despite a linear increase in flow in all receiving basins over the time period from 1981 to 1985, the total phosphorus loadings to the Great Lakes decreased from 1606 tonnes/yr to 1426 tonnes/yr, a decline of approximately 11 percent. Plants in the Lake Ontario/St. Lawrence River Basin accomplished the largest reduction over this time period (121 tonnes/year). However, it should be noted that this improvement in basin phosphorus loadings may not be maintained as more plants near hydraulic capacity. More specifically, in 1985, a total of 16 plants (16.7 percent) that had exceeded their design capacity, contributed to 20.0 percent of the total flows to all basins. This is predicted to increase to 31 plants (32.3 percent) contributing to 38.9 percent of the total flows in 1990.

6.0 PHOSPHORUS MANAGEMENT STRATEGIES

Four phosphorus management strategies that would decrease the total phosphorus loading to the Lake Erie and Lake Ontario/St. Lawrence drainage basins were considered. Scenario 0 represented those loadings actually experienced in 1984 and 1985.

In Scenario 1, all plants would comply with annual average effluent phosphorus concentration of 1 mg/L or less. If plants have site specific requirement less than 1 mg/L, these would be met. In Scenario 2, all plants would comply with a monthly average effluent phosphorus requirement of 1 mg/L or less for all months. Again, more stringent site specific requirements would be met. In Scenario 3, large plants would comply with a more stringent monthly effluent requirement of 0.9 mg TP/L or less while the remaining plants would meet the 1 mg TP/L monthly requirement or their site specific requirement. For the Lake Erie Drainage basin, "large" plants would include those with design capacities greater than 100,000 m^3/d (Kitchener WPCP, Greenway WPCP and Westerly WPCP), comprising 39 percent of the total basin design flow capacity. For the Lake Ontario drainage basin, plants with greater than 200,000 m^3/d design capacity (Woodward Ave. WPCP, Highland Creek WPCP, Humber WPCP, Main WPCP, Lakeview WPCP and York-Durham WPCP), comprising 68 percent of the total basin design flow capacity would be considered as large plants. In Scenario 4, all plants would achieve monthly average effluent phosphorus concentrations of 0.9 mg/L for all months. Site specific requirements would also be met.

The stated scenarios were evaluated as described in Section 3.4.1 with respect to their effects on phosphorus loadings to the individual receiving basins (Lake Erie and Lake Ontario/St. Lawrence River). In the evaluation, actual 1984 and 1985 data were utilized. If a particular plant already met the requirements of the Scenario being evaluated, its performance was not downgraded. More specifically, only those modifications necessary to bring a plant into compliance for the Scenario were made. The "base" loading was defined as the actual 1983 total basin phosphorus loading. Basin loadings increased in 1986 to 1990 in proportion to the projected increases in basin flows (see Section 5.0).

6.1 Effect on Basin Loadings

Based on the 1984 and 1985 performance data, total phosphorus loadings from each plant were calculated for each scenario using the methods described in Section 3.4.1. The loadings from the individual plants are presented in Tables B-1 to B-8, Appendix B. A summation of plant loadings and flows for each basin for each scenario allowed calculation of total basin loadings for each management strategy. The basin loading reduction attributable to each scenario in each year was calculated by taking the difference between the calculated basin loading and the "base load" (actual 1983 load).

The actual, hypothetical and projected loadings and loading reductions for the Lake Erie Drainage basin are shown in Table 33 and Figure 28. Since most plants in this basin have consistently performed well, as indicated by aggregate average phosphorus concentrations of less than the compliance limit of 1 mg/L, only a 37.7 tonne/year (18 percent) loading reduction can be achieved in the most severe case (Scenario 4). As indicated in Figure 28, the "base load" to the Lake Erie Basin would be exceeded in 1986 if Scenario 1 was implemented as a phosphorus management approach strategy. The most severe management approach (Scenario 4) maintains the total phosphorus load to Lake Erie at levels below the "base load" until almost 1989.

The actual, hypothetical and projected loadings and loading reductions for each scenario for the Lake Ontario drainage basin are shown in Table 34 and Figure 29. In 1985, a loading reduction of 87.6 tonnes per year would have been realized if each plant had complied with the existing MOE effluent requirements (Scenario 1). If compliance were evaluated using monthly averages of 1 mg/L and each plant complied (Scenario 2), this reduction would have increased to 134.2 tonnes/year. Since there are two large plants that did not comply in 1985 (Woodward Ave. WPCP and Humber WPCP), bringing these plants into compliance to a limit of 0.9 mg/L (Scenario 3) caused an even more significant loading reduction to 160.4 tonnes/year. Scenario 4 caused only a small decrease in loading compared to Scenario 3.

As shown in Figure 29, the "base load" to the Lake Ontario/St. Lawrence River Basin would not be exceeded until 1990 if all plants complied with the existing annual average discharge requirement of 1 mg/L TP. Imposition of a monthly average compliance requirement (Scenario 2) extends this time period until 1995. Imposition of more stringent (0.9 mg/L) effluent concentration limits, on a selected (Scenario 3) or across-the-board basis (Scenario 4), extends the time period to 1998 and 1999, respectively.

TABLE 33. COMPARISON OF PHOSPHORUS MANAGEMENT STRATEGIES - EFFECT OF TP LOADING REDUCTION TO LAKE ERIE DRAINAGE BASIN

		HYPOTHETICAL TP LOADINGS (tonnes/yr) (BASED ON ACTUAL FLOW & TP DATA)			PROJECTED TP LOADINGS (Based on Projected Flows and 1985 Aggregate Average Effluent TP Concentration)				
	DESCRIPTION	1983	1984	1985	1986	1987	1988	1989	1990
FLOWS ($10^3 m^3/d$)	Actual and projected flows based on linear regression of 1981-1985 basin flows.	761.96	772.03	841.37	856.81	887.84	918.87	949.90	980.94
SCENARIO 0	Loadings based on 1984 and 1985 data, and projected flows.	246.85	240.16 (6.69)	247.07 (-0.22)	251.60 (-4.75)	260.72 (-13.87)	269.83 (-22.98)	278.94 (-32.09)	288.05 (-41.20)
SCENARIO 1	All plants comply annually with average effluent TP $\leq$ 1 mg/L or site-specific requirements.		225.90 (20.95)	237.75 (9.10)	242.11 (4.74)	250.88 (4.03)	259.65 (-12.88)	268.42 (-21.57)	277.19 (-30.34)
SCENARIO 2	All plants comply monthly with average effluent TP $\leq$ 1 mg/L or site-specific requirements.		215.19 (31.69)	226.03 (20.82)	230.18 (16.67)	238.51 (8.34)	246.85 (0)	255.19 (-8.34)	263.52 (-16.67)
SCENARIO 3	Plants with >100,000 m^3/d capacity comply with 0.9 mg/L, all others comply with 1 mg/L or site-specific requirements - monthly basis		213.03 (33.82)	223.65 (23.20)	227.75 (19.10)	236.00 (10.85)	244.25 (2.6)	252.50 (-5.65)	260.75 (-13.90)
SCENARIO 4	All plants comply monthly with average effluent TP $\leq$ 0.9 mg/L or site-specific requirements.		209.15 (37.70)	219.84 (27.01)	223.87 (22.98)	231.98 (14.87)	240.09 (6.76)	248.20 (-1.35)	256.31 (-9.46)

( ) = Loading Reduction from 1983 Load (tonnes/yr)

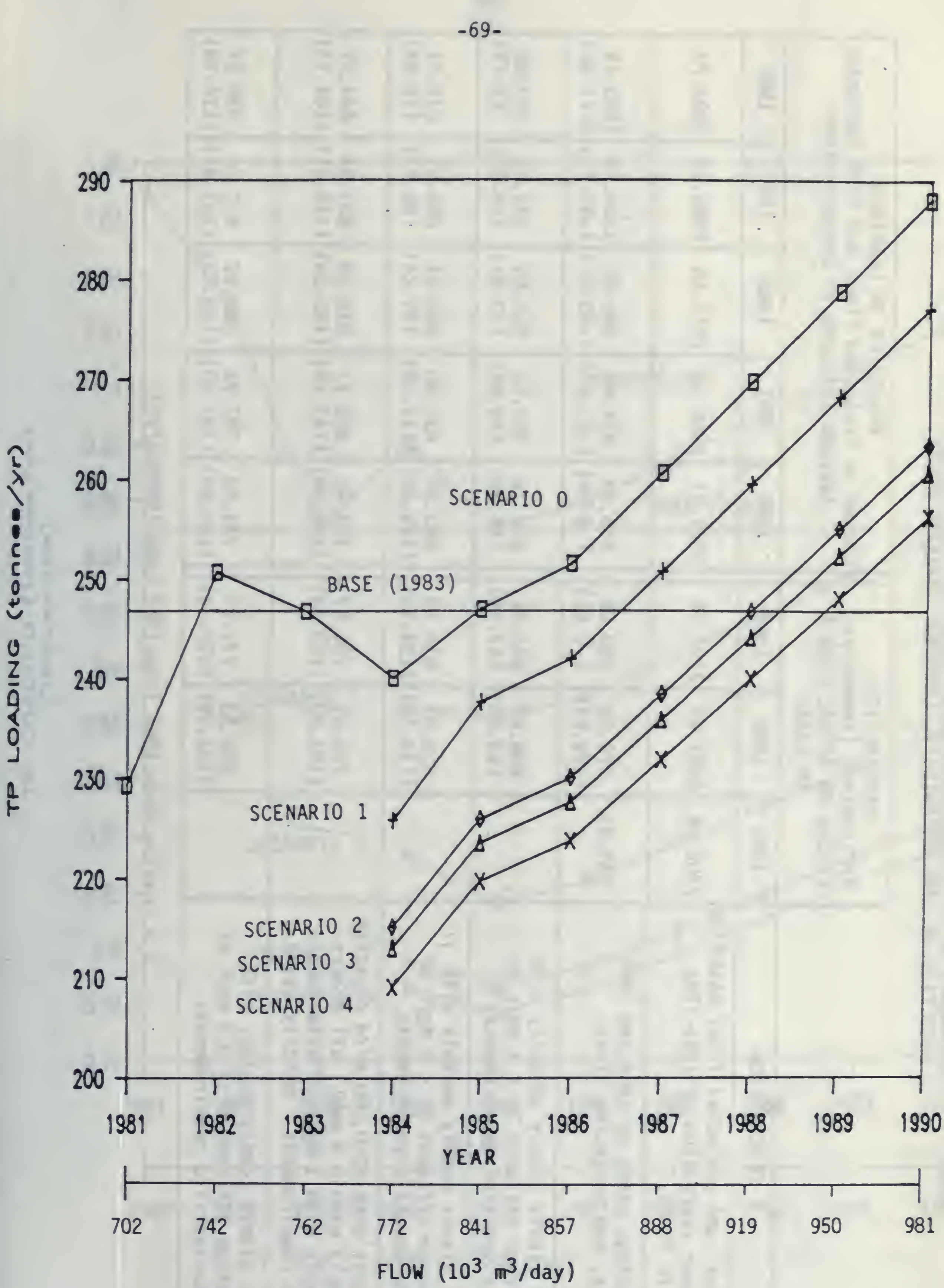

FIGURE 28 - EFFECT OF PHOSPHORUS MANAGEMENT STRATEGIES ON PHOSPHORUS LOADINGS ON THE LAKE ERIE DRAINAGE BASIN

TABLE 34. COMPARISON OF PHOSPHORUS MANAGEMENT STRATEGIES - EFFECT OF TP LOADING REDUCTION TO LAKE ONTARIO/ST. LAWRENCE DRAINAGE BASIN

		HYPOTHETICAL TP LOADINGS (tonnes/yr) (BASED ON ACTUAL FLOW & TP DATA)			PROJECTED TP LOADINGS (Based on Projected Flows and 1985 Aggregate Average Effluent TP Concentration)				
	DESCRIPTION	1983	1984	1985	1986	1987	1988	1989	1990
FLOWS ($10^3 m^3/d$)	Actual and projected flows based on linear regression of 1981-1985 basin flows.	2702.66	2687.59	2795.14	2821.41	2866.98	2912.56	2956.13	3003.70
SCENARIO 0	Loadings based on 1984 and 1985 data, and projected flows.	949.45	979.08 (-29.63)	950.06 (-0.61)	958.99 (-9.54)	974.48 (-25.03)	989.97 (-40.52)	1004.78 (-55.33)	1020.95 (-71.50)
SCENARIO 1	All plants comply annually with average effluent TP $\leq$ 1 mg/L or site-specific requirements.		886.02 (63.43)	881.86 (67.59)	890.15 (59.30)	904.53 (44.92)	918.91 (30.54)	932.65 (16.80)	947.66 (1.79)
SCENARIO 2	All plants comply monthly with average effluent TP $\leq$ 1 mg/L or site-specific requirements.		832.92 (116.53)	815.93 (134.15)	823.60 (125.85)	836.90 (112.55)	850.21 (99.24)	862.92 (86.53)	876.81 (72.64)
SCENARIO 3	Plants with >200,000 m^3/d capacity comply with 0.9 mg/L, all others comply with 1 mg/L or site-specific requirements - monthly basis		795.65 (153.80)	786.07 (163.38)	793.46 (155.99)	806.27 (143.18)	819.09 (130.36)	831.34 (118.11)	844.72 (104.73)
SCENARIO 4	All plants comply monthly with average effluent TP $\leq$ 0.9 mg/L or site-specific requirements.		785.53 (163.92)	777.27 (172.18)	784.58 (164.87)	797.25 (152.20)	809.92 (139.53)	822.04 (127.41)	835.27 (114.18)

( ) = Loading Reduction from 1983 Load (tonnes/yr)

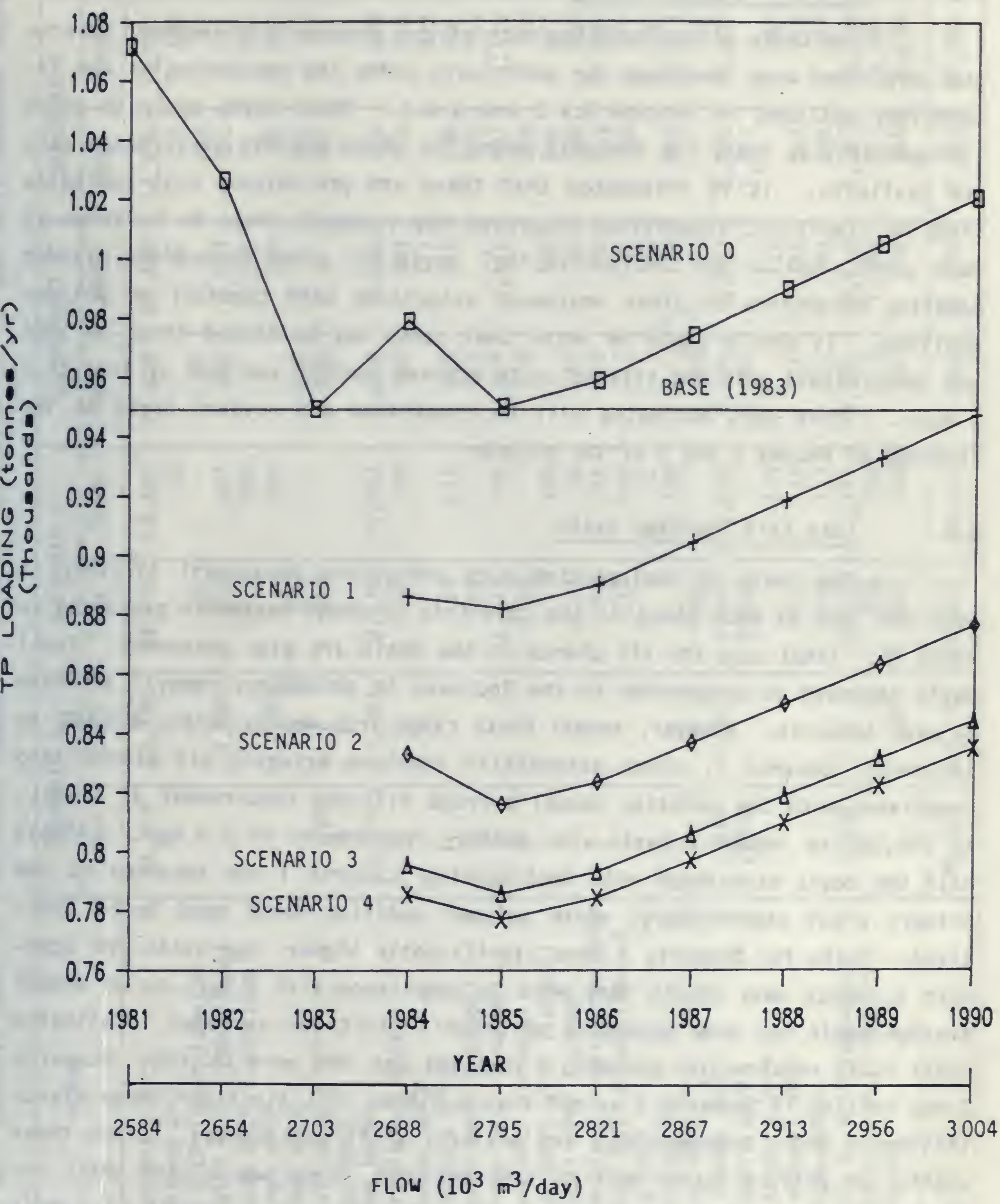

FIGURE 29 - EFFECT OF MANAGEMENT STRATEGIES ON PHOSPHORUS LOADINGS TO THE LAKE ONTARIO DRAINAGE BASIN

6.2 Costs of Implementation

The costs of implementing each of the phosphorus management strategies described were developed for each basin using the methodologies and assumptions outlined in Section 3.4.2 and 3.4.3. These costs apply to years 1984 and 1985 as these are the only years for which monthly performance data are available. It is reiterated that these are preliminary cost estimates based on simplistic assumptions regarding the remedial steps to be taken at each plant, and do not include capital costs for plant expansions, sludge handling expansions or other equipment associated with chemical or polymer addition. It should again be noted that costs may be biased since in 1984 and 1985, plants were not attempting to achieve monthly averages of less than 1 mg/L. These cost estimates will be reassessed and revised based on the findings of Phases 2 and 3 of the program.

6.2.1 Lake Erie Drainage Basin

The costs of implementing each phosphorus management strategy in 1984 and 1985 at each plant in the Lake Erie drainage basin are presented in Table 35. Total cost for all plants in the basin are also presented. Total costs increase in proportion to the increase in phosphorus removal achieved by each scenario. However, annual costs range from approximately $20,000 to implement Scenario 1, which essentially involves bringing all plants into compliance with the existing annual average effluent requirement of 1 mg/L, to $50,000 to impose a basin-wide monthly requirement of 0.9 mg/L. Almost half the costs associated with implementing Scenario 1 are incurred at one primary plant (Amherstburg) where polymer addition would need to be practised. Costs for Scenario 2 were significantly higher than costs for Scenario 1, since many plants that were in compliance with 1 mg/L on an annual average basis had some months in which this limit was exceeded. Estimated total costs required for Scenario 2 for 1984 and 1985 were $80,000. Scenario 3 was similar to Scenario 2 except that a 0.9 mg TP/L limit for large plants (Kitchener WPCP, Greenway WPCP and Westerly WPCP) was imposed. Since these plants did perform fairly well in 1984 and 1985, there was a very small increase in costs for 1984 and 1985 to $83,000. Scenario 4 imposed a 0.9 mg/L phosphorus limit on all plants causing a relatively small cost increase at each plant compared to Scenario 2. The cumulative effect resulted in an estimated total cost of $95,000.

TABLE 35. RELATIVE COSTS OF PHOSPHORUS MANAGEMENT STRATEGY SCENARIOS FOR THE LAKE ERIE DRAINAGE BASIN

PLANT	SCENARIO 1		SCENARIO 2		SCENARIO 3		SCENARIO 4	
	1984	1985	1984	1985	1984	1985	1984	1985
Amherstburg WPCP	13,614	10,784	13,800	13,480	13,800	13,480	13,956	13,765
Brantford WPCP				50		50	12	150
Galt WPCP (Cambridge)			60		60		284	58
Hespeler WPCP (Cambridge)		1,450	625	1,937	625	1,937	861	2,222
Preston WPCP (Cambridge)				200		200		284
Chatham WPCP		40		260		260	58	355
Dresden WPCP			336		336		432	19
Dunnville WPCP	20		344		344		367	
Fergus WPCP								
Guelph WPCP	6,670	7,137	8,174	8,083	8,174	8,803	8,380	8,846
Ingersoll New WPCP			102	294	102	294	131	354
Kitchener WPCP						177		177
Leamington WPCP			116	611	116	611	236	641
Adelaide WPCP (London)			121		121		470	134
Greenway WPCP (London)			1,271	746	1,907	1,119	1,907	1,119
Oxford WPCP (London)			156		156		259	48
Pottersburg WPCP (London)				186		186	166	372
Vauxhall WPCP (London)			177	80	177	80	300	160
Belle River - Maidstore WPCP			355	346	355	346	503	484
Corunna P.V. Plant (Moore)			237	622	237	622	362	770
Paris WPCP				31		31		55
Sarnia WPCP				1,738		1,738	1,923	5,213
Simcoe WPCP			154		154			195
St. Thomas WPCP	5,199	2,904	4,976	5,532	4,976	5,532	6,258	4,978
Stratford WPCP	1,070		2,455		2,455		2,641	
Tillsonburg WPCP				129		129		282
Wallaceburg WPCP			131	146	131	146	183	219
Waterloo WPCP			730	193	730	193	990	257
Little R. WPCP (Windsor)	3,038		5,812	3,347	6,387	3,918	6,387	3,918
Westerly WPCP (Windsor)			334	504	519	1,285	519	1,285
Woodstock		280	107	662	107	662	244	1,030
TOTALS	29,611	22,595	40,573	39,177	41,969	41,079	47,829	47,390

Figure 30 compares the relative costs of each phosphorus management strategy to the costs of bringing plants into compliance with the existing annual average 1 mg/L TP concentration limit. It can be noted that the total costs increase with the severity of the phosphorus requirements, to a maximum for Scenario 4 at 210 percent of the cost of Scenario 1 (1984).

6.2.2 Lake Ontario/St. Lawrence River Drainage Basin

The individual plant and total Lake Ontario/St. Lawrence basin costs for 1984 and 1985 for Scenarios 1 to 4 are presented in Table 36. Costs incurred by the implementation of any strategy in the Lake Ontario Basin are significantly higher than costs for the same management strategy in the Lake Erie Basin. There are two major reasons for this difference. A larger number of plants in the Lake Ontario basin requiring remediation use the more expensive alum for phosphorus removal, as opposed to ferrous chloride. In addition, the chemical addition at Woodward Ave. WPCP is a large component of the cost in this basin.

The costs associated with either Scenario 1 or Scenario 2 relate to remediation at the Woodward Ave. WPCP, since this plant was not adding chemicals to achieve phosphorus removal. Costs increased significantly for Scenario 2 compared to Scenario 1. Most plants were required to improve performance for some period of time in Scenario 2 in order to meet the monthly average requirement.

Selective imposition of more severe (0.9 mg/L) effluent requirements at large plants (Scenario 3) results in a further significant increase in phosphorus removal costs. Of the five plants affected (Woodward Avenue WPCP, Humber WPCP, Toronto Main WPCP, Lakeview WPCP and Highland Creek WPCP), only Lakeview typically met this requirement. Therefore, the other four plants incurred substantial costs to improve performance. As anticipated, basin-wide imposition of a monthly average 0.9 mg/L TP limit resulted in the highest cost, totalling near $1 million over two years (1984 and 1985).

Figure 31 presents a histogram of the costs of each Scenario relative to the costs of meeting the present MOE effluent requirements (Scenario 1). The costs were significantly less in 1985 as a result of better performance at a number of plants. Costs increased with the severity of the phosphorus requirement, to a maximum for Scenario 4 of 310 percent of the cost of Scenario 1 in 1984.

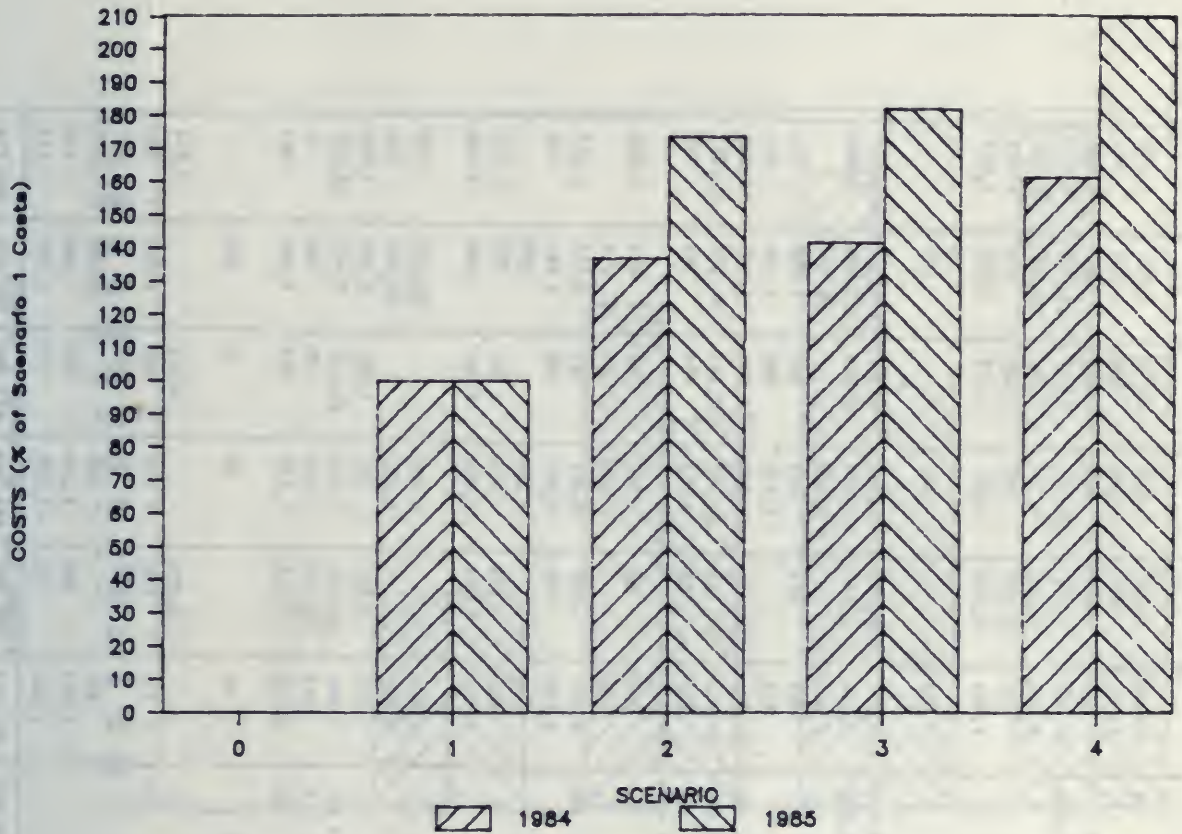

FIGURE 30 - RELATIVE COSTS TO IMPLEMENT PHOSPHORUS MANAGEMENT STRATEGIES IN THE LAKE ERIE DRAINAGE BASIN

TABLE 36. RELATIVE COSTS OF PHOSPHORUS MANAGEMENT STRATEGY SCENARIOS FOR THE LAKE ONTARIO DRAINAGE BASIN

PLANT	SCENARIO 1		SCENARIO 2		SCENARIO 3		SCENARIO 4	
	1984	1985	1984	1985	1984	1985	1984	1985
Belleville WPCP [1]	--	--	--	--	--	--	--	--
Brockville WPCP	2,828	0	4,968	2,349	4,968	2,349	5,481	2,349
Skyway WPCP (Burlington)			1,188	107	1,188	107	1,323	240
Campbellford WPCP			240	894	240	894	267	1,325
Cobourg WPCP No. 1		3,678	10,721	7,767	10,721	7,767	14,164	9,779
Cornwall WPCP			8,713	7,336	8,713	7,336	12,587	12,226
Dundas			293	1,036	293	1,036	712	1,332
Anger Avenue WPCP (Fort Erie)			1,643	1,379	1,643	1,379	2,464	2,067
Baker Road WPCP (Grimsby)			7		7		20	23
Acton WPCP (Halton Hills)			133		133		172	
Georgetown WPCP (Halton Hills) [2]	--	--	--	--	--	--	--	--
Woodward Ave. WPCP (Hamilton)	129,896	185,649	259,753	278,474	340,926	292,397	340,926	292,397
Iroguois WPCP	2,044	2,848	2,044	2,848	2,044	2,848	2,044	2,848
Kingston WPCP			6,103		6,103		18,309	
Kingston Twp. WPCP			729	363	729	363	1,208	756
Highland Creek WPCP (Metro Toronto)			903		2,710	282	2,710	282
Humber WPCP (Metro Toronto)	19,643	5,115	21,636	12,786	25,499	16,036	25,499	16,036
Main WPCP (Metro Toronto)		20,110	21,112	52,157	34,421	69,543	34,421	69,543
North WPCP (Metro Toronto)			231	444	231	444	707	736
Milton WPCP								
Clarkson WPCP (Mississauga)			263	363	263	363	843	1,068
Lakeview WPCP (Mississauga)			138		219		219	
Napanee WPCP	6,273	788	6,341	828	6,341	828	6,735	2,514
Port Darlington WPCP (Newcastle)	3,520		4,007	259	4,007	259	4,260	345
Stanford WPCP (Niagara Falls)			598		598		598	
South East WPCP (Oakville)			421	949	421	949	655	1,394
South West WPCP (Oakville)			2,432	2,024	2,432	2,024	3,040	2,589
Orangeville WPCP								
Harmony Cr. WPCP 1 (Oshawa)	995		8,289		8,289		10,057	282
Harmony Cr. WPCP 2 (Oshawa)	1,024		8,532		8,532		10,352	290
Peterborough WPCP			734	1,581	734	1,581	1,239	1,924
York Durham WPCP (Pickering)		3,815	3,966	15,110	3,966	15,110	7,948	26,437
Picton WPCP			512	70	512	70	506	93
Seaway WPCP (Port Colborne)	584	388	1,179	815	1,179	815	1,395	903
Port Hope WPCP								
Prescott-Edwardsburgh WPCP			95		95	95	379	
Port Dalhousie WPCP (St. Catharines)								
Port Weller WPCP (St. Catharines)				5,015		5,015		9,574
Trenton WPCP		504	234	508	234	508	301	508
Welland WPCP				62		62		161
Corbett Cr. WPCP (Whitby)			831		831		1,384	124
Pringle Cr. 1 WPCP (Whitby)			1,209	350	1,209	350	1,406	458
Pringle Cr. 2 WPCP (Whitby)			1,555	730	1,555	730	1,951	1,113
TOTALS	164,788	222,895	381,753	396,604	481,983	431,445	516,282	461,716

1. Belleville WPCP was under construction in 1984.
2. Georgetown WPCP had equipment problems in 1984 causing a typical treatment efficiencies.

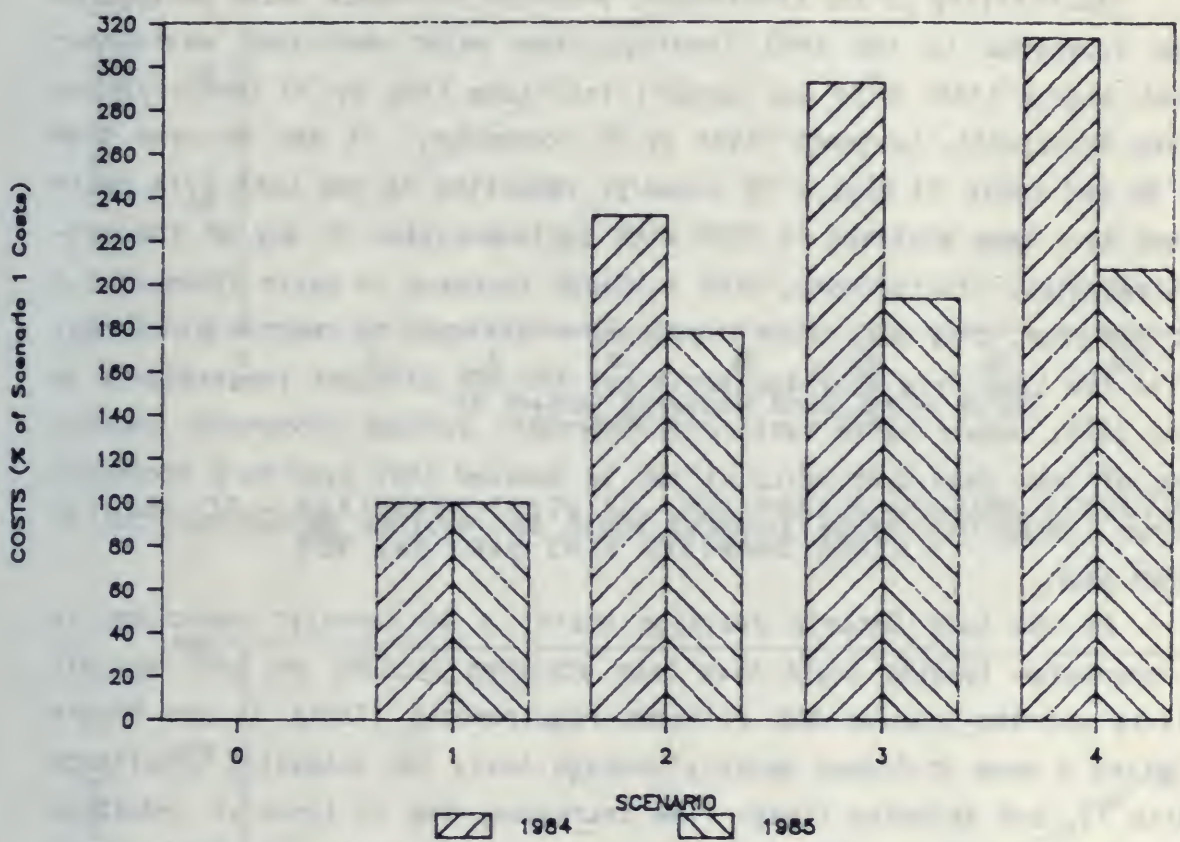

FIGURE 31 - RELATIVE COSTS TO IMPLEMENT PHOSPHORUS MANAGEMENT STRATEGIES IN THE LAKE ONTARIO/ST. LAWRENCE DRAINAGE BASIN

6.3 Summary

In the evaluation of the phosphorus management alternatives, a number of factors must be considered. These include the basin phosphorus loading reduction that can be achieved compared to what is desired, and the ease of implementation and enforcing of any of the strategies.

The Ministry of the Environment proposed to reduce total phosphorus loadings (compared to the 1983 loading) from major municipal wastewater treatment plants (4546 m^3/d and larger) into Lake Erie by 30 tonnes/yr and into Lake Ontario/St. Lawrence River by 50 tonnes/yr. It can be seen from Figure 28 and Table 33 that a 30 tonne/yr reduction in the Lake Erie basin would not have been achieved in 1985 with implementation of any of the proposed strategies. Furthermore, with a linear increase in basin flows of 2.5 percent per year, this goal would become more difficult to reach. Since most plants in the Lake Erie drainage basin met the MOE effluent requirements in 1984 and 1985, resulting in basin-wide aggregate average phosphorus concentrations of less than 0.85 mg/L, it can be deduced that even more stringent phosphorus limits than those proposed would be required to achieve the 30 tonnes/yr goal.

In the Lake Ontario drainage basin, a 50 tonne/yr reduction in total phosphorus loading could have been achieved in 1984 and 1985 had all the plants met the present MOE effluent requirements (Table 33 and Figure 26). Using a more stringent monthly average basis for assessing compliance (Scenario 2), and assuming linear flow increases, the 50 tonne/yr reduction could be achieved until 1991. Application of more stringent requirements (Scenarios 3 and 4) would cause an even greater reduction in total basin phosphorus loading.

There was a significant linear relationship between the phosphorus loading reduction achieved and the costs of achieving the reduction in both basins as shown in Figure 32 (Lake Erie) and Figure 33 (Lake Ontario). It should be noted that plants were not actually attempting to achieve the requirements of Scenarios 2, 3 and 4, and therefore, costs may be biased. Based on these costs data, the average cost of achieving further reductions in phosphorus loading in Lake Erie was approximately $1,560/tonne compared to a cost of $2,660/tonne in Lake Ontario. The higher costs in the Lake Ontario drainage basin can be attributed to:

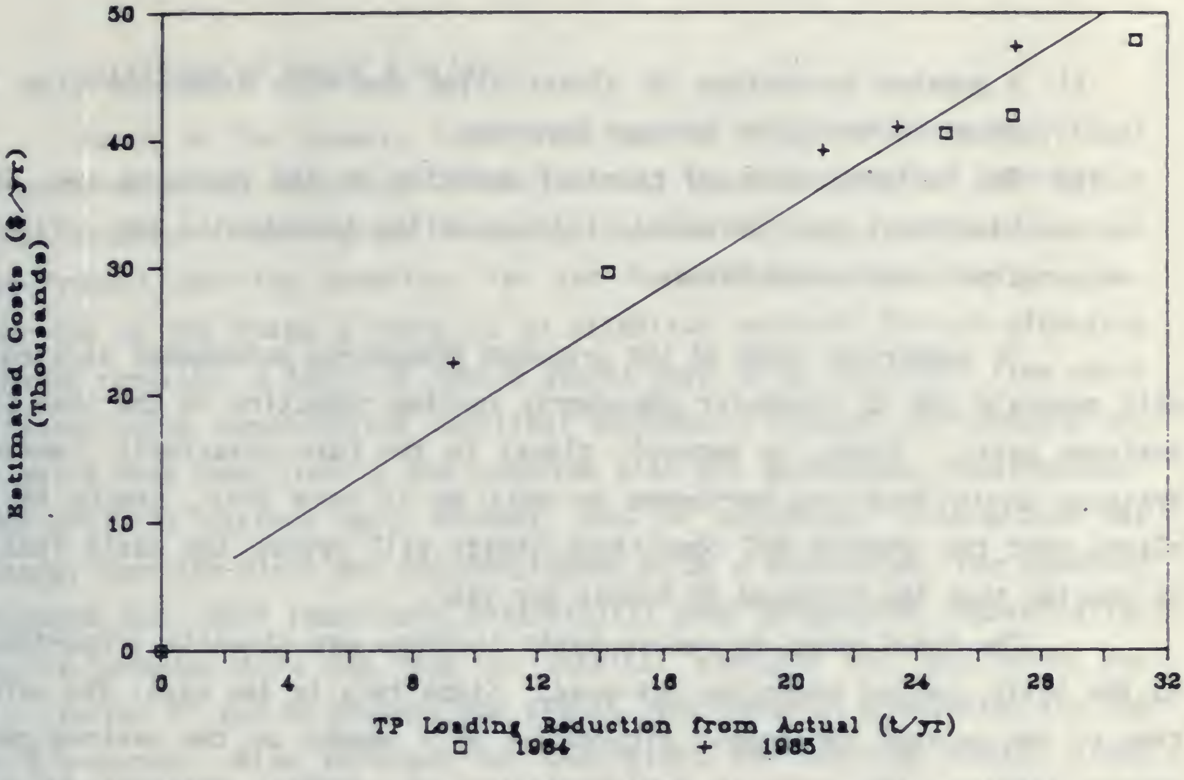

FIGURE 32 - ESTIMATED COSTS VS. PHOSPHORUS LOADING REDUCTION FOR THE LAKE ERIE DRAINAGE BASIN

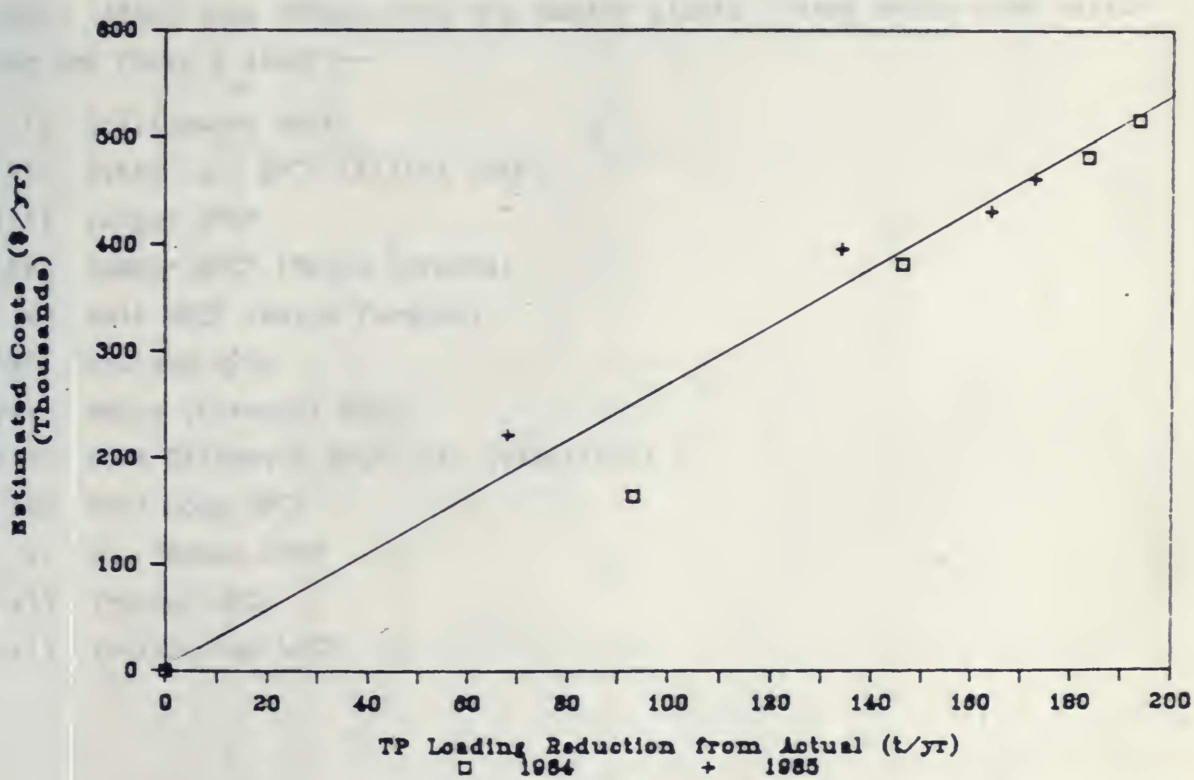

FIGURE 33 - ESTIMATED COSTS VS. PHOSPHORUS LOADING REDUCTION FOR THE LAKE ONTARIO/ST. LAWRENCE DRAINAGE BASIN

i) A greater percentage of plants using the more expensive alum instead of ferric or ferrous chloride.

ii) The implementation of chemical addition to the Woodward Ave. WPCP (Hamilton) and increased sludge handling (dewatering and incineration) costs associated.

To summarize, none of the proposed phosphorus management strategies will generate the 30 tonnne/yr phosphorus loading reduction in the Lake Erie drainage basin. Since, in general, plants in the Lake Ontario/St. Lawrence drainage basin have not performed as well as in Lake Erie, simply having plants meet the present MOE compliance limits will reduce the basin loading by greater than the proposed 50 tonnes per year.

The total costs to reduce basin loadings are directly proportional to the basin loading reduction achieved. Since this is the case, the selection of the optimal management alternative will depend on the desired phosphorus loading, the ease of implementation of remedial measures at each plant, and the difficulties associated with enforcing a new compliance requirement.

7.0 SELECTION OF PHASE 2 PLANTS

Based on the summary tables in Section 4 that present individual plant performance and compliance histories, and the more detailed information that was obtained through plant contact, a number of plants were recommended to the Project Steering Committee for the Phase 2 field sampling program. The purpose of the Phase 2 study is to establish critical factors affecting phosphorus removal. A total of twelve plants were to be selected; five which have historically demonstrated excellent phosphorus removal performance and seven which have consistently not complied with MOE phosphorus requirements. If the critical factors were obvious, and no additional information was necessary, then the plant was not considered to be a candidate. For example, at Woodward Ave. WPCP (Hamilton) historically poor phosphorus removal efficiency is because there has been no chemical addition for phosphorus removal. Tables 37 and 38 present the plants considered as candidates for the Phase 2 program. Also included for each plant are drainage basin, plant type, effluent TP concentrations and compliance data for 1984 and 1985, design and 1984/1985 flows, and comments related to plant performance.

These plants were submitted to the Project Steering Committee, 9 May 1986. After some discussion, the twelve plants listed below were selected for the Phase 2 study.

i) Collingwood WPCP
ii) Esten Lake WPCP (Elliot Lake)
iii) Fergus WPCP
iv) Humber WPCP (Metro Toronto)
v) Main WPCP (Metro Toronto)
vi) Midland WPCP
vii) Moore (Corunna) WPCP
viii) Port Dalhousie WPCP (St. Catharines)
ix) Port Hope WPCP
x) St. Thomas WPCP
xi) Trenton WPCP
xii) York-Durham WPCP

TABLE 37. CANDIDATE SITES FOR PHASE 2 ASSESSMENT
SUPERIOR PERFORMANCE

PLANT	BASIN	PLANT TYPE	EFFLUENT TP (mg/L)		NO. OF MONTHS OUT OF COMPLIANCE ('84 & '85)	FLOW (10^3 m^3)			COMMENT
			1984	1985		DESIGN	1984	1985	
1. Port Dalhousie WPCP (St. Catharines)	Ontario	CAS	0.54	0.39	0	61.4	32.4	39.1	64% of Design Flow
2. Fergus WPCP	Erie	CAS	0.64	0.54	0	5.0	3.7	3.9	78% of Design Flow
3. Sturgeon Falls WPCP	Huron	CAS	0.32	0.41	0	4.5	6.8	5.7	Inf. TP 3.3 mg/L
4. Picton WPCP	Ontario	Cont. Stab.	0.70	0.52	1	4.5	3.2	3.3	0.5 mg/L Summer Requirement
5. Port Hope WPCP	Ontario	HRAS	0.51	0.57	1	9.1	8.4	9.1	Inf. TP 3.6 mg/L
6. Trenton WPCP	Ontario	CAS	0.58	0.66	1	15.9	10.8	11.3	0.5 mg/L Summer Requirement
7. Paris WPCP	Erie	EA	0.58	0.55	1	7.05	2.2	2.5	36% of Design Flow
8. Midland WPCP	Huron	CAS	0.57	0.57	1	13.6	9.2	11.0	81% of Design Flow

TABLE 38. CANDIDATE SITES FOR PHASE 2 ASSESSMENT PLANTS NOT CONSISTENTLY COMPLYING

PLANT	BASIN	PLANT TYPE	EFFLUENT TP (mg/L)		NO. OF MONTHS OUT OF COMPLIANCE ('84 & '85)	FLOW (10^3 m^3)			COMMENT
			1984	1985		DESIGN	1984	1985	
1. North Bay WPCP	UGL	CAS	1.49	1.67	22	36.4	32.5	40.3	High Inf. TP
2. Amherstburg WPCP	Erie	Primary	3.50	3.25	20	4.6	5.0	4.6	Primary Plant
3. Collingwood WPCP	UGL	CAS	1.49	1.92	18	24.5	17.3	18.5	Influent TP > 10 mg/L
4. Humber WPCP (Metro Toronto)	Ontario	CAS	1.44	1.06	16	409.14	339.3	377.7	Influent TP 8-10 mg/L
5. Napanee WPCP	Ontario	CAS	2.46	1.23	15	9.1	6.0	6.2	High Industrial Load
6. Woodward WPCP (Hamilton)	Ontario	CAS	1.23	1.30	15	409.1	323.1	307.8	No Chemical Addition
7. St. Thomas WPCP	Erie	CAS	1.51	1.12	11	40.9	18.5	17.4	< 50% Design Flow
8. Esten Lake WPCP (Elliot Lake)	UGL	CAS	1.35	1.10	11	13.0	10.9	12.5	On-Line Dose Control
9. Hespeler WPCP (Cambridge)	Erie	HRAS	0.91	1.31	10	9.3	5.3	5.5	Poor Clarifier Design
10. Moore (Corunna) WPCP	Erie	EA	0.87	0.84	11	4.5	1.4	2.8	Inconsistent Performance
11. Main WPCP (Metro Toronto)	Ontario	CAS	0.97	1.08	10	818.28	676.2	683.1	Inconsistent Performance
12. Port Darlington WPCP (Newmarket)	Ontario	CAS	1.78	0.93	9	4.5	6.4	8.1	180% of Design Flow
13. Goderich WPCP	UGL	CAS	1.13	0.90	11	9.1	9.6	11.2	120% of Design Flow
14. Iroquois WPCP	Ontario	Primary	2.15	NA	6/8	5.0	3.2	4.5	Only 1 mo. data in 1985
15. York Durham WPCP (Pickering)	Ontario	CAS	0.98	1.03	8	181.8	121.1	149.7	Inconsistent Performance

8.0 REFERENCES

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APPENDIX A

ACTUAL PLANT TP LOADINGS,
FLOWS AND AGGREGATE AVERAGE
PHOSPHORUS CONCENTRATIONS FOR 1983-1985

ACTUAL PHOSPHORUS LOADINGS - LAKE ERIE DRAINAGE BASIN

PLANT		1983 AVG. EFF. TP CONC. (mg/L)	1983 AVERAGE DAILY Q (1000 m3/d)	1983 TOTAL P LOADING (tonnes/yr)	1984 AVG. EFF. TP CONC. (mg/L)	1984 AVERAGE DAILY Q (1000 m3/d)	1984 TOTAL P LOADING (tonnes/yr)	1985 AVG. EFF. TP CONC. (mg/L)	1985 AVERAGE DAILY Q (1000 m3/d)	1985 TOTAL P LOADING (tonnes/yr)
AMHERSTBURG		2.90	4.96	5.24	3.50	5.00	6.39	3.25	4.55	5.39
BRANTFORD		0.74	49.31	13.37	0.74	54.01	14.59	0.75	58.45	15.94
CAMBRIDGE (GALT)		1.01	32.83	12.09	0.89	31.50	10.24	0.80	31.99	9.32
CAMBRIDGE (HESPELER)		0.89	5.15	1.68	0.91	5.34	1.77	1.31	5.50	2.63
CAMBRIDGE (PRESTON)		0.71	8.02	2.08	0.56	8.01	1.64	0.75	8.47	2.33
CHATHAM	**	0.70	25.23	6.45	0.79	25.71	7.45	0.99	29.71	10.78
DRESDEN		0.25	1.66	0.15	0.51	2.14	0.40	0.39	2.35	0.33
DUNNVILLE		0.49	4.48	0.80	1.01	4.59	1.69	0.60	4.93	1.09
FERGUS		0.63	3.21	0.73	0.64	3.72	0.87	0.54	3.88	0.78
GUELPH	**	1.55	44.30	25.06	0.96	43.51	15.18	0.82	47.69	14.35
INGERSOLL (NEW)		0.31	3.99	0.45	0.46	5.27	0.89	0.81	4.34	1.28
KITCHENER		0.87	66.00	20.84	0.69	68.46	17.32	0.76	64.87	17.91
LEAMINGTON		1.00	7.20	2.63	0.57	6.73	1.40	0.93	6.78	2.31
LONDON (ADELAIDE)		0.97	14.87	5.26	0.93	16.82	5.68	0.86	17.06	5.34
LONDON (GREENWAY)		0.99	122.37	44.22	0.93	127.47	43.37	0.78	131.85	37.49
LONDON (OXFORD)		0.98	4.89	1.75	0.87	5.25	1.68	0.74	5.36	1.44
LONDON (POTTERSBURG)		0.96	17.93	6.28	0.84	17.34	5.35	0.65	17.40	4.12
LONDON (VAUXHALL)		0.97	18.59	6.58	0.80	18.57	5.41	0.62	19.56	4.41
MAIDSTONE (BELLE RIVER)		0.39	5.36	0.77	0.62	5.00	1.14	0.84	6.35	1.95
MOORE (CORUNNA)		0.98	1.90	0.68	0.86	1.42	0.45	0.84	2.85	0.87
PARIS		0.89	1.92	0.62	0.58	2.24	0.47	0.55	2.53	0.50
SARNIA		0.88	52.32	16.81	0.78	55.18	15.70	0.83	54.41	16.43
SIMCOE	**	0.53	9.71	1.87	0.80	9.26	2.71	0.71	9.47	2.46
ST. THOMAS		0.80	18.32	5.37	1.51	43.66	24.11	1.12	18.92	7.75
STRATFORD	**	0.40	22.50	3.30	0.54	22.05	4.34	0.23	24.99	2.07
STRATHROY LAGOON		1.19	3.79	1.64	1.60	3.43	2.00	1.19	4.37	1.90
TILLSONBURG		0.74	5.47	1.47	0.40	5.30	0.78	0.78	5.41	1.55
WALLACEBURG		0.34	6.12	0.75	0.65	5.47	1.30	0.42	8.85	1.37
WATERLOO		0.77	39.71	11.12	0.97	41.54	14.75	0.74	45.20	12.29
WINDSOR (LITTLE)		0.43	32.28	5.07	1.22	31.60	14.09	0.81	44.90	13.21
WINDSOR (WESTERLY)		0.89	105.01	34.11	0.71	100.48	25.88	0.85	124.48	38.59
WOODSTOCK		0.92	22.59	7.58	0.94	21.13	7.25	1.02	23.92	8.89
		0.89	761.96	246.85	0.88	797.22	256.27	0.80	841.37	247.07

ACTUAL LOADINGS - LAKE ONTARIO / ST. LAWERENCE DRAINAGE BASIN

PLANT	1983 AVG. EFF. TP CONC. (mg/L)	1983 AVERAGE DAILY Q (1000 m3/d)	1983 TOTAL P LOADING (tonnes/yr)	1984 AVG. EFF. TP CONC. (mg/L)	1984 AVERAGE DAILY Q (1000 m3/d)	1984 TOTAL P LOADING (tonnes/yr)	1985 AVG. EFF. TP CONC. (mg/L)	1985 AVERAGE DAILY Q (1000 m3/d)	1985 TOTAL P LOADING (tonnes/yr)
BELLEVILLE	1.11	29.43	11.95	0.95	46.23	15.96	0.49	39.91	7.18
BROCKVILLE	1.43	15.69	8.19	1.01	14.68	5.40	0.81	18.51	5.49
BURLINGTON (SKYWAY)	0.54	86.60	17.07	0.69	87.54	22.04	0.64	64.91	15.18
CALEDON (BOLTON) **	0.18	3.46	0.23	0.51	3.52	0.66	0.44	4.10	0.66
CAMPBELLFORD	0.70	7.01	1.80	0.69	7.12	1.80	0.84	6.66	2.04
COBOURG (1)	0.81	14.18	4.19	0.70	12.96	3.29	1.62	8.50	5.02
CORNWALL (CORNWALL)	0.97	49.17	17.49	0.98	48.46	17.27	0.97	47.64	16.91
DUNDAS **	0.60	11.77	2.58	0.78	12.75	3.64	0.82	13.33	3.99
FORT ERIE (ANGER AVE.)	0.85	13.05	4.05	0.75	12.84	3.54	0.73	12.92	3.43
GRIMSBY (BAKER ROAD)	0.86	10.71	3.36	0.70	10.73	2.76	0.56	10.75	2.21
HALTON HILLS (ACTON) **	0.89	2.55	0.83	0.54	3.40	0.67	0.46	3.92	0.66
HALTON HILLS (GEORGT.)**	0.66	9.27	2.23	1.16	9.96	4.20	0.50	11.14	2.02
HAMILTON (WOODWARD)	1.10	287.76	115.54	1.23	323.09	145.64	1.30	307.78	145.68
IROQUOIS	2.30	3.49	2.93	1.89	3.19	2.20	0.00	4.46	0.00
KINGSTON TWP.	0.92	16.26	5.47	0.94	15.55	5.36	0.88	16.33	5.27
KINGSTON	0.89	60.02	19.53	0.96	57.26	20.11	0.76	66.43	18.50
LINDSAY LAGOON	0.31	8.96	1.01	0.83	12.89	3.90	0.53	18.33	3.56
METRO TORONTO(HIGHLAND)	1.05	162.75	62.37	0.90	156.83	51.70	0.77	163.35	45.73
METRO TORONTO(HUMBER)	1.04	365.50	138.74	1.44	339.27	178.48	1.06	377.69	146.21
METRO TORONTO(MAIN)	0.89	737.59	239.61	0.97	676.22	239.39	1.08	683.07	269.18
METRO TORONTO(N.TORONTO)	1.01	35.37	13.04	0.85	35.77	11.08	0.85	34.69	10.72
MILTON **	0.57	9.59	2.00	0.35	9.89	1.25	0.27	12.32	1.23
MISSISSAUGA (CLARKSON)	1.07	67.05	26.18	0.89	75.27	24.40	0.91	71.11	23.53
MISSISSAUGA (LAKEVIEW)	0.89	190.60	62.01	0.84	198.62	61.24	0.65	230.41	54.38
NAPANEE	2.20	5.41	4.34	2.32	6.02	5.11	1.23	6.22	2.80
NEWCASTLE(PORT DARLINGT)	1.50	6.73	3.70	1.78	6.40	4.15	0.93	8.07	2.73
NEWMARKET	0.80	15.05	4.39	0.00	0.00	0.00	0.00	0.00	0.00
NIAGARA FALLS (STAMFORD)	1.00	56.24	20.53	0.62	56.10	12.70	0.45	57.01	9.45
OAKVILLE (SE)	0.96	12.37	4.33	0.87	12.48	3.96	0.85	13.27	4.11
OAKVILLE (SW)	1.53	28.23	15.77	0.92	24.79	8.32	0.89	28.92	9.39
ORANGEVILLE **	0.30	7.35	0.80	0.35	7.32	0.95	0.25	8.10	0.74
OSHAWA (HARMONY CR.1)	0.89	24.18	7.86	1.01	25.86	9.55	0.60	27.49	6.01
OSHAWA (HARMONY CR.2)	0.89	25.88	8.41	1.04	26.60	10.11	0.50	27.59	5.04
PETERBOROUGH	0.77	53.14	14.94	0.80	54.50	15.87	0.83	55.62	16.78
PICKERING (DUFFIN CREEK)	1.74	95.16	60.57	0.97	121.05	42.85	1.03	149.65	56.38
PICTON	0.52	3.34	0.63	0.70	3.15	0.80	0.52	3.31	0.63
PORT COLBORNE (SEAWAY)	0.89	13.94	4.53	1.16	14.08	5.94	1.05	13.19	5.04
PORT HOPE	0.53	7.42	1.45	0.51	8.35	1.55	0.57	9.56	1.99
PRESCOTT (EDWARDSBURGH)	0.85	4.60	1.42	0.90	4.42	1.46	0.62	5.15	1.16
ST.CATHARINES (P.DALH.)	0.53	36.32	7.03	0.54	32.40	6.40	0.39	41.53	5.86
ST.CATHARINES (P.WELLER)	0.74	35.82	9.68	0.57	35.83	7.43	0.77	41.99	11.83
TRENTON	0.83	9.85	2.98	0.58	10.80	2.28	0.66	11.15	2.69
WELLAND	0.55	41.89	8.41	0.36	40.16	5.35	0.72	33.44	8.79
WHITBY (CORBETT CREEK)	0.75	10.85	2.99	0.88	10.92	3.50	0.59	13.41	2.87
WHITBY (PRINGLE CREEK 1)	0.39	4.25	0.60	0.99	6.03	2.18	0.63	5.62	1.30
WHITBY (PRINGLE CREEK 2)	0.69	6.82	1.71	1.16	6.29	2.66	0.92	6.59	2.22
	0.96	2702.66	949.45	1.00	2687.59	979.08	0.93	2795.14	946.59

ACTUAL PHOSPHOROUS LOADINGS - LAKE HURON DRAINAGE BASIN

PLANT	1983 AVG. EFF. TP CONC. (mg/L)	1983 AVERAGE DAILY Q (1000 m3/d)	1983 TOTAL P LOADING (tonnes/yr)	1984 AVG. EFF. TP CONC. (mg/L)	1984 AVERAGE DAILY Q (1000 m3/d)	1984 TOTAL P LOADING (tonnes/yr)	1985 AVG. EFF. TP CONC. (mg/L)	1985 AVERAGE DAILY Q (1000 m3/d)	1985 TOTAL P LOADING (tonnes/yr)
BARRIE	0.93	22.75	7.76	0.96	26.53	9.28	0.50	26.11	4.77
BRADFORD **	0.37	3.05	0.41	0.87	3.35	1.06	0.41	3.11	0.46
COLLINGWOOD	1.70	17.04	10.55	1.53	17.34	9.66	1.89	18.52	12.77
ELLIOT LAKE (ESTER L.)**	0.67	8.50	2.08	1.35	10.94	5.40	1.10	12.50	5.03
GODERICH	1.50	7.14	3.91	1.13	9.57	3.93	0.90	11.16	3.68
HANOVER	0.63	3.72	0.86	0.88	3.64	1.17	0.87	4.26	1.35
HUNTSVILLE	0.37	4.01	0.54	0.32	4.53	0.53	0.76	4.80	1.32
MIDLAND	0.32	9.00	1.05	0.57	9.23	1.93	0.57	10.90	2.28
NORTH BAY	1.20	32.36	14.17	1.49	32.51	17.63	1.67	40.25	24.59
ORILLIA	0.31	17.48	1.98	0.40	18.39	2.69	0.81	19.16	5.66
OWEN SOUND	1.27	19.63	9.12	0.83	19.50	5.89	0.83	22.31	6.80
PARRY SOUND	0.88	4.21	1.35	0.79	3.35	0.97	0.53	3.93	0.76
PORT ELGIN	1.55	3.64	2.06	1.87	3.37	2.30	1.45	4.15	2.20
SAULT STE MARIE	4.11	46.97	70.50	4.74	45.74	79.14	4.01	50.27	73.50
STURGEON FALLS	0.44	6.92	1.10	0.32	6.75	0.80	0.41	5.57	0.84
SUDBURY	1.49	54.85	29.83	1.82	54.84	36.34	2.07	52.02	39.36
VALLEY EAST(HAMNER ECT)	1.48	4.83	2.61	1.11	5.09	2.06	0.68	5.60	1.39
WALDEN (MIKKOLA)	2.60	0.90	0.85	2.34	1.17	0.99	2.56	1.19	1.11
WALKERTON	1.31	4.89	2.33	0.98	5.05	1.81	0.94	5.87	2.01
WASAGA BEACH **	0.00	0.67	0.00	0.00	0.75	0.00	0.00	1.02	0.00
	1.64	272.54	163.05	1.79	281.65	183.60	1.72	302.69	189.88

ACTUAL PHOSPHOROUS LOADINGS - LAKE SUPERIOR DRAINAGE BASIN

	1983			1984			1985		
PLANT	AVG. EFF. TP CONC. (mg/L)	AVERAGE DAILY Q (1000 m3/d)	TOTAL P LOADING (tonnes/yr)	AVG. EFF. TP CONC. (mg/L)	AVERAGE DAILY Q (1000 m3/d)	TOTAL P LOADING (tonnes/yr)	AVG. EFF. TP CONC. (mg/L)	AVERAGE DAILY Q (1000 m3/d)	TOTAL P LOADING (tonnes/yr)
THUNDER BAY	1.50	100.61	55.23	1.25	104.23	47.64	0.94	113.95	38.95
	1.50	100.61	55.23	1.25	104.23	47.64	0.94	113.95	38.95

APPENDIX B

HYPOTHETICAL PLANT TP LOADINGS, FLOWS AND AGREEGATE AVERAGE PHOSPHORUS CONCENTRATIONS FOR PHOSPHORUS MANAGEMENT SCENARIOS - LAKE ERIE AND LAKE ONTARIO/ST. LAWRENCE DRAINAGE BASINS

PREDICTED LOADINGS FOR SCENARIO 1 - LAKE ERIE DRAINAGE BASIN

All plants comply with annual TP = 1 mg/L and site specific req'ts.	1984			1985		
PLANT	AGGREGATE AVG. EFF. TP CONC. (mg/L)	AVERAGE DAILY Q (1000 m3/d)	TOTAL P LOADING (tonnes/yr)	AGGREGATE AVG. EFF. TP CONC. (mg/L)	AVERAGE DAILY Q (1000 m3/d)	TOTAL P LOADING (tonnes/yr)
AMHERSTBURG	1.00	5.00	1.83	1.00	4.55	1.66
BRANTFORD	0.74	54.01	14.59	0.75	58.45	15.94
CAMBRIDGE (GALT)	0.89	31.50	10.24	0.80	31.99	9.32
CAMBRIDGE (HESPELER)	0.91	5.34	1.77	1.00	5.50	2.01
CAMBRIDGE (PRESTON)	0.56	8.01	1.64	0.75	8.47	2.33
CHATHAM **	0.79	25.71	7.45	0.99	29.71	10.78
DRESDEN	0.51	2.14	0.40	0.39	2.35	0.33
DUNNVILLE	1.00	4.59	1.68	0.60	4.93	1.09
FERGUS	0.64	3.72	0.87	0.54	3.88	0.76
GUELPH **	0.65	43.51	10.37	0.61	47.69	10.69
INGERSOLL (NEW)	0.46	5.27	0.89	0.81	4.34	1.28
KITCHENER	0.69	68.46	17.32	0.76	64.87	17.91
LEAMINGTON	0.57	6.73	1.40	0.93	6.78	2.31
LONDON (ADELAIDE)	0.93	16.82	5.68	0.86	17.06	5.34
LONDON (GREENWAY)	0.93	127.47	43.37	0.78	131.85	37.49
LONDON (OXFORD)	0.87	5.25	1.68	0.74	5.36	1.44
LONDON (POTTERSBURG)	0.84	17.34	5.35	0.65	17.40	4.12
LONDON (VAUXHALL)	0.80	18.57	5.41	0.62	19.56	4.41
MAIDSTONE (BELLE RIVER)	0.62	5.00	1.14	0.84	6.35	1.95
MOORE (CORUNNA)	0.86	1.42	0.45	0.84	2.85	0.87
PARIS	0.58	2.24	0.47	0.55	2.53	0.50
SARNIA	0.78	55.18	15.70	0.83	54.41	16.43
SIMCOE **	0.80	9.26	2.71	0.71	9.47	2.46
ST. THOMAS	1.00	18.47	6.74	1.00	18.92	6.91
STRATFORD **	0.50	22.05	4.03	0.23	24.99	2.07
STRATHROY LAGOON	1.00	3.43	1.25	1.00	4.37	1.59
TILLSONBURG	0.40	5.30	0.78	0.78	5.41	1.55
WALLACEBURG	0.65	5.47	1.30	0.42	8.85	1.37
WATERLOO	0.97	41.54	14.75	0.74	45.20	12.29
WINDSOR (LITTLE)	1.00	31.60	11.53	0.81	44.90	13.21
WINDSOR (WESTERLY)	0.71	100.48	25.88	0.85	124.48	38.59
WOODSTOCK	0.94	21.13	7.25	1.00	23.92	8.73
	0.80	772.03	225.90	0.77	841.37	237.75

PREDICTED LOADINGS FOR SCENERIO 2 - LAKE ERIE DRAINAGE BASIN

All plants comply with monthly TP = 1 mg/L and site specific req'ts. PLANT		1984 AGGREGATE AVG. EFF. TP CONC. (mg/L)	1984 AVERAGE DAILY Q (1000 m3/d)	1984 TOTAL P LOADING (tonnes/yr)	1985 AGGREGATE AVG. EFF. TP CONC. (mg/L)	1985 AVERAGE DAILY Q (1000 m3/d)	1985 TOTAL P LOADING (tonnes/yr)
AMHERSTBURG		1.00	5.00	1.83	1.00	4.55	1.66
BRANTFORD		0.74	54.01	14.59	0.74	58.45	15.86
CAMBRIDGE (GALT)		0.88	31.50	10.17	0.80	31.99	9.32
CAMBRIDGE (HESPELER)		0.78	5.34	1.52	0.89	5.50	1.78
CAMBRIDGE (PRESTON)		0.56	8.01	1.64	0.66	8.47	2.05
CHATHAM	**	0.79	25.71	7.45	0.85	29.71	9.21
DRESDEN		0.45	2.14	0.35	0.39	2.35	0.33
DUNNVILLE		0.63	4.59	1.06	0.60	4.93	1.09
FERGUS		0.64	3.72	0.87	0.54	3.88	0.76
GUELPH	**	0.63	43.51	10.02	0.60	47.69	10.52
INGERSOLL (NEW)		0.42	5.27	0.80	0.70	4.34	1.11
KITCHENER		0.69	68.46	17.32	0.76	64.87	17.91
LEAMINGTON		0.55	6.73	1.35	0.76	6.78	1.89
LONDON (ADELAIDE)		0.91	16.82	5.58	0.86	17.06	5.34
LONDON (GREENWAY)		0.86	127.47	39.92	0.75	131.85	35.92
LONDON (OXFORD)		0.80	5.25	1.53	0.74	5.36	1.44
LONDON (POTTERSBURG)		0.84	17.34	5.35	0.64	17.40	4.06
LONDON (VAUXHALL)		0.78	18.57	5.29	0.61	19.56	4.36
MAIDSTONE (BELLE RIVER)		0.58	5.00	1.06	0.80	6.35	1.85
MOORE (CORUNNA)		0.75	1.42	0.39	0.66	2.85	0.69
PARIS		0.58	2.24	0.47	0.54	2.53	0.49
SARNIA		0.78	55.18	15.70	0.78	54.41	15.53
SIMCOE	**	0.76	9.26	2.58	0.71	9.47	2.46
ST. THOMAS		0.95	18.47	6.38	0.86	18.92	5.94
STRATFORD	**	0.50	22.05	4.03	0.23	24.99	2.07
STRATHROY LAGOON		0.96	3.43	1.21	0.86	4.37	1.37
TILLSONBURG		0.40	5.30	0.78	0.75	5.41	1.49
WALLACEBURG		0.62	5.47	1.23	0.40	8.85	1.28
WATERLOO		0.86	41.54	13.08	0.72	45.20	11.89
WINDSOR (LITTLE)		0.79	31.60	9.12	0.63	44.90	10.35
WINDSOR (WESTERLY)		0.69	100.48	25.49	0.83	124.48	37.88
WOODSTOCK		0.91	21.13	7.02	0.93	23.92	8.10
		0.76	772.03	215.16	0.74	841.37	226.03

PREDICTED LOADINGS FOR SCENERIO 3 - LAKE ERIE DRAINAGE BASIN

Monthly compliance: > 100,000 m3/d - 0.9 mg/L; All others - 1 mg/L	1984			1985		
PLANT	AGGREGATE AVG. EFF. TP CONC. (mg/L)	AVERAGE DAILY Q (1000 m3/d)	TOTAL P LOADING (tonnes/yr)	AGGREGATE AVG. EFF. TP CONC. (mg/L)	AVERAGE DAILY Q (1000 m3/d)	TOTAL P LOADING (tonnes/yr)
AMHERSTBURG	1.00	5.00	1.83	1.00	4.55	1.66
BRANTFORD	0.74	54.01	14.59	0.74	58.45	15.86
CAMBRIDGE (GALT)	0.88	31.50	10.17	0.80	31.99	9.32
CAMBRIDGE (HESPELER)	0.78	5.34	1.52	0.89	5.50	1.78
CAMBRIDGE (PRESTON)	0.56	8.01	1.64	0.66	8.47	2.05
CHATHAM **	0.79	25.71	7.45	0.85	29.71	9.21
DRESDEN	0.45	2.14	0.35	0.39	2.35	0.33
DUNNVILLE	0.63	4.59	1.06	0.60	4.93	1.09
FERGUS	0.64	3.72	0.87	0.54	3.88	0.76
GUELPH **	0.63	43.51	10.02	0.60	47.69	10.52
INGERSOLL (NEW)	0.42	5.27	0.80	0.70	4.34	1.11
KITCHENER	0.69	68.46	17.32	0.74	64.87	17.50
LEAMINGTON	0.55	6.73	1.35	0.76	6.78	1.89
LONDON (ADELAIDE)	0.91	16.82	5.58	0.86	17.06	5.34
LONDON (GREENWAY)	0.82	127.47	38.36	0.73	131.85	35.10
LONDON (OXFORD)	0.80	5.25	1.53	0.74	5.36	1.44
LONDON (POTTERSBURG)	0.84	17.34	5.35	0.64	17.40	4.06
LONDON (VAUXHALL)	0.78	18.57	5.29	0.61	19.56	4.36
MAIDSTONE (BELLE RIVER)	0.58	5.00	1.06	0.80	6.35	1.85
MOORE (CORUNNA)	0.75	1.42	0.39	0.66	2.85	0.69
PARIS	0.58	2.24	0.47	0.54	2.53	0.49
SARNIA	0.78	55.18	15.70	0.78	54.41	15.63
SIMCOE **	0.76	9.26	2.58	0.71	9.47	2.46
ST. THOMAS	0.95	18.47	6.38	0.86	18.92	5.94
STRATFORD **	0.50	22.05	4.03	0.23	24.99	2.07
STRATHROY LAGOON	0.96	3.43	1.21	0.86	4.37	1.37
TILLSONBURG	0.40	5.30	0.78	0.75	5.41	1.49
WALLACEBURG	0.62	5.47	1.23	0.40	8.85	1.28
WATERLOO	0.86	41.54	13.08	0.72	45.20	11.89
WINDSOR (LITTLE)	0.79	31.60	9.12	0.63	44.90	10.35
WINDSOR (WESTERLY)	0.69	100.48	25.21	0.81	124.48	36.74
WOODSTOCK	0.91	21.13	7.02	0.93	23.92	8.10
	0.76	772.03	213.32	0.73	841.37	223.65

PREDICTED LOADINGS FOR SCENERIO 4 - LAKE ERIE DRAINAGE BASIN

Monthly compliance for all plants: TP = Ø.9 mg/L	1984			1985		
PLANT	AGGREGATE AVG. EFF. TP CONC. (mg/L)	AVERAGE DAILY Q (1000 m3/d)	TOTAL P LOADING (tonnes/yr)	AGGREGATE AVG. EFF. TP CONC. (mg/L)	AVERAGE DAILY Q (1000 m3/d)	TOTAL P LOADING (tonnes/yr)
AMHERSTBURG	Ø.9Ø	5.ØØ	1.64	Ø.9Ø	4.55	1.49
BRANTFORD	Ø.74	54.Ø1	14.58	Ø.74	58.45	15.71
CAMBRIDGE (GALT)	Ø.86	31.5Ø	9.91	Ø.79	31.99	9.26
CAMBRIDGE (HESPELER)	Ø.73	5.34	1.43	Ø.83	5.5Ø	1.66
CAMBRIDGE (PRESTON)	Ø.56	8.Ø1	1.64	Ø.64	8.47	1.97
CHATHAM **	Ø.77	25.71	7.2Ø	Ø.8Ø	29.71	8.72
DRESDEN	Ø.43	2.14	Ø.33	Ø.38	2.35	Ø.32
DUNNVILLE	Ø.61	4.59	1.Ø2	Ø.6Ø	4.93	1.Ø9
FERGUS	Ø.64	3.72	Ø.87	Ø.54	3.88	Ø.76
GUELPH **	Ø.62	43.51	9.87	Ø.6Ø	47.69	1Ø.38
INGERSOLL (NEW)	Ø.4Ø	5.27	Ø.78	Ø.67	4.34	1.Ø6
KITCHENER	Ø.69	68.46	17.32	Ø.74	64.87	17.5Ø
LEAMINGTON	Ø.52	6.73	1.28	Ø.72	6.78	1.79
LONDON (ADELAIDE)	Ø.86	16.82	5.27	Ø.83	17.Ø6	5.15
LONDON (GREENWAY)	Ø.82	127.47	38.36	Ø.73	131.85	35.1Ø
LONDON (OXFORD)	Ø.76	5.25	1.46	Ø.71	5.36	1.4Ø
LONDON (POTTERSBURG)	Ø.81	17.34	5.15	Ø.63	17.4Ø	4.ØØ
LONDON (VAUXHALL)	Ø.75	18.57	5.12	Ø.6Ø	19.56	4.3Ø
MAIDSTONE (BELLE RIVER)	Ø.56	5.ØØ	1.Ø3	Ø.77	6.35	1.78
MOORE (CORUNNA)	Ø.69	1.42	Ø.36	Ø.62	2.85	Ø.65
PARIS	Ø.58	2.24	Ø.47	Ø.53	2.53	Ø.49
SARNIA	Ø.77	55.18	15.5Ø	Ø.76	54.41	15.11
SIMCOE **	Ø.75	9.26	2.54	Ø.71	9.47	2.46
ST. THOMAS	Ø.88	18.47	5.95	Ø.82	18.92	5.65
STRATFORD **	Ø.5Ø	22.Ø5	4.ØØ	Ø.23	24.99	2.Ø7
STRATHROY LAGOON	Ø.87	3.43	1.Ø9	Ø.8Ø	4.37	1.28
TILLSONBURG	Ø.4Ø	5.3Ø	Ø.78	Ø.74	5.41	1.45
WALLACEBURG	Ø.6Ø	5.47	1.2Ø	Ø.38	8.86	1.24
WATERLOO	Ø.82	41.54	12.47	Ø.71	45.2Ø	11.75
WINDSOR (LITTLE)	Ø.75	31.6Ø	8.64	Ø.6Ø	44.9Ø	9.81
WINDSOR (WESTERLY)	Ø.69	1ØØ.48	25.21	Ø.81	124.48	36.74
WOODSTOCK	Ø.86	21.13	6.67	Ø.88	23.92	7.71
	Ø.74	772.Ø3	2Ø9.15	Ø.72	841.37	219.84

PREDICTED LOADINGS FOR SCENERIO 1 - LAKE ONTARIO / ST. LAWERENCE DRAINAGE BASIN

Annual compliance for all plants: TP < 1 mg/L	1984			1985		
PLANT	AGGREGATE AVG. EFF. TP CONC. (mg/L)	AVERAGE DAILY Q (1000 m3/d)	TOTAL P LOADING (tonnes/yr)	AGGREGATE AVG. EFF. TP CONC. (mg/L)	AVERAGE DAILY Q (1000 m3/d)	TOTAL P LOADING (tonnes/yr)
BELLEVILLE	0.81	48.23	13.67	0.49	39.91	7.18
BROCKVILLE	1.00	14.68	5.36	0.81	18.51	5.49
BURLINGTON (SKYWAY)	0.69	87.54	22.04	0.64	64.91	15.18
CALEDON (BOLTON) **	0.51	3.52	0.66	0.44	4.10	0.66
CAMPBELLFORD	0.69	7.12	1.80	0.84	6.66	2.04
COBOURG (1)	0.70	12.96	3.29	1.00	8.50	3.10
CORNWALL (CORNWALL)	0.98	48.46	17.27	0.97	47.64	16.91
DUNDAS **	0.78	12.75	3.64	0.82	13.33	3.99
FORT ERIE (ANGER AVE.)	0.75	12.84	3.54	0.73	12.92	3.43
GRIMSBY (BAKER ROAD)	0.70	10.73	2.76	0.56	10.75	2.21
HALTON HILLS (ACTON) **	0.54	3.40	0.67	0.46	3.92	0.66
HALTON HILLS (GEORGT.)**	1.00	9.96	3.63	0.50	11.14	2.02
HAMILTON (WOODWARD)	1.00	323.09	117.93	1.00	307.78	112.34
IROQUOIS	1.00	3.19	1.16	1.00	4.46	1.63
KINGSTON TWP.	0.94	15.55	5.36	0.88	16.33	5.27
KINGSTON	0.96	57.26	20.11	0.76	66.43	18.50
LINDSAY LAGOON	0.83	12.89	3.90	0.53	18.33	3.56
METRO TORONTO(HIGHLAND)	0.90	156.83	51.70	0.77	163.36	45.73
METRO TORONTO(HUMBER)	1.00	339.27	123.83	1.00	377.69	137.86
METRO TORONTO(MAIN)	0.97	676.22	239.39	1.00	683.07	249.32
METRO TORONTO(N.TORONTO)	0.85	35.77	11.08	0.85	34.89	10.72
MILTON **	0.32	9.89	1.15	0.27	12.32	1.23
MISSISSAUGA (CLARKSON)	0.89	75.27	24.40	0.91	71.11	23.53
MISSISSAUGA (LAKEVIEW)	0.84	198.62	61.24	0.65	230.41	54.38
NAPANEE	1.00	6.02	2.20	1.00	6.22	2.27
NEWCASTLE(PORT DARLINGT)	1.00	6.40	2.34	0.93	8.07	2.73
NEWMARKET	0.00	0.00	0.00	0.00	0.00	0.00
NIAGARA FALLS (STAMFORD)	0.62	56.10	12.70	0.45	57.01	9.45
OAKVILLE (SE)	0.87	12.48	3.96	0.85	13.27	4.11
OAKVILLE (SW)	0.92	24.79	8.32	0.89	28.92	9.39
ORANGEVILLE **	0.35	7.32	0.95	0.25	8.10	0.74
OSHAWA (HARMONY CR.1)	1.00	25.86	9.44	0.60	27.49	6.01
OSHAWA (HARMONY CR.2)	1.00	26.60	9.71	0.50	27.59	5.04
PETERBOROUGH	0.80	54.50	15.87	0.83	55.62	16.78
PICKERING (DUFFIN CREEK)	0.97	121.05	42.85	1.00	149.65	54.62
PICTON	0.51	3.15	0.59	0.51	3.31	0.62
PORT COLBORNE (SEAWAY)	1.00	14.08	5.14	1.00	13.19	4.81
PORT HOPE	0.51	8.35	1.55	0.57	9.56	1.99
PRESCOTT (EDWARDSBURGH)	0.90	4.42	1.46	0.62	5.15	1.16
ST.CATHARINES (P.DALH.)	0.54	32.40	6.40	0.39	41.53	5.86
ST.CATHARINES (P.WELLER)	0.57	35.83	7.43	0.77	41.99	11.83
TRENTON	0.56	10.80	2.22	0.57	11.15	2.33
WELLAND	0.36	40.16	5.35	0.72	33.44	8.79
WHITBY (CORBETT CREEK)	0.88	10.92	3.50	0.59	13.41	2.87
WHITBY (PRINGLE CREEK 1)	0.99	6.03	2.18	0.63	5.62	1.30
WHITBY (PRINGLE CREEK 2)	1.00	6.29	2.30	0.92	6.59	2.22
	0.90	2687.59	886.02	0.86	2795.13	881.86

PREDICTED LOADINGS FOR SCENERIO 2 - LAKE ONTARIO / ST. LAWERENCE DRAINAGE BASIN

Monthly compliance for all plants: TP = 1 mg/L	1984			1985		
PLANT	AGGREGATE AVG. EFF. TP CONC. (mg/L)	AVERAGE DAILY Q (1000 m3/d)	TOTAL P LOADING (tonnes/yr)	AGGREGATE AVG. EFF. TP CONC. (mg/L)	AVERAGE DAILY Q (1000 m3/d)	TOTAL P LOADING (tonnes/yr)
BELLEVILLE	0.67	46.23	11.30	0.49	39.91	7.18
BROCKVILLE	0.92	14.68	4.94	0.75	18.51	5.06
BURLINGTON (SKYWAY)	0.62	87.54	19.76	0.63	64.91	15.03
CALEDON (BOLTON) **	0.51	3.52	0.66	0.43	4.10	0.65
CAMPBELLFORD	0.68	7.12	1.77	0.77	6.66	1.86
COBOURG (1)	0.51	12.96	2.42	0.68	8.50	2.12
CORNWALL (CORNWALL)	0.89	48.46	15.72	0.91	47.64	15.75
DUNDAS **	0.76	12.75	3.52	0.70	13.33	3.42
FORT ERIE (ANGER AVE.)	0.70	12.84	3.29	0.72	12.92	3.39
GRIMSBY (BAKER ROAD)	0.70	10.73	2.74	0.56	10.75	2.21
HALTON HILLS (ACTON) **	0.48	3.40	0.59	0.46	3.92	0.66
HALTON HILLS (GEORGT.)**	0.85	9.96	3.08	0.50	11.14	2.02
HAMILTON (WOODWARD)	0.95	323.09	112.44	0.91	307.78	102.77
IROQUOIS	0.88	3.19	1.02	0.97	4.46	1.57
KINGSTON TWP.	0.86	15.55	4.89	0.86	16.33	5.11
KINGSTON	0.93	57.26	19.38	0.76	66.43	18.50
LINDSAY LAGOON	0.45	12.89	2.12	0.46	18.33	3.09
METRO TORONTO(HIGHLAND)	0.89	156.83	50.79	0.77	163.35	45.73
METRO TORONTO(HUMBER)	0.97	339.27	119.78	0.87	377.69	120.30
METRO TORONTO(MAIN)	0.90	676.22	221.95	0.92	683.07	228.19
METRO TORONTO(N.TORONTO)	0.83	35.77	10.87	0.81	34.69	10.23
MILTON **	0.32	9.89	1.15	0.27	12.32	1.23
MISSISSAUGA (CLARKSON)	0.88	75.27	24.05	0.88	71.11	22.95
MISSISSAUGA (LAKEVIEW)	0.82	198.62	59.29	0.65	230.41	54.38
NAPANEE	0.98	6.02	2.16	0.98	6.22	2.22
NEWCASTLE(PORT DARLINGT)	0.91	6.40	2.13	0.84	8.07	2.49
NEWMARKET	0.00	0.00	0.00	0.00	0.00	0.00
NIAGARA FALLS (STAMFORD)	0.62	56.10	12.60	0.45	57.01	9.45
OAKVILLE (SE)	0.81	12.48	3.67	0.77	13.27	3.71
OAKVILLE (SW)	0.78	24.79	7.07	0.76	28.92	8.04
ORANGEVILLE **	0.35	7.32	0.95	0.25	8.10	0.74
OSHAWA (HARMONY CR.1)	0.78	25.86	7.35	0.57	27.49	5.77
OSHAWA (HARMONY CR.2)	0.79	26.60	7.65	0.50	27.59	5.04
PETERBOROUGH	0.75	54.50	14.94	0.70	55.62	14.21
PICKERING (DUFFIN CREEK)	0.92	121.05	40.66	0.89	149.65	48.83
PICTON	0.51	3.15	0.59	0.51	3.31	0.62
PORT COLBORNE (SEAWAY)	0.84	14.08	4.32	0.81	13.19	3.88
PORT HOPE	0.51	8.35	1.55	0.57	9.56	1.99
PRESCOTT (EDWARDSBURGH)	0.88	4.42	1.43	0.62	5.15	1.16
ST.CATHARINES (P.DALH.)	0.54	32.40	6.40	0.39	41.53	5.86
ST.CATHARINES (P.WELLER)	0.57	35.83	7.43	0.75	41.99	11.50
TRENTON	0.55	10.80	2.17	0.57	11.15	2.33
WELLAND	0.36	40.16	5.35	0.70	33.44	8.57
WHITBY (CORBETT CREEK)	0.82	10.92	3.27	0.59	13.41	2.87
WHITBY (PRINGLE CREEK 1)	0.73	6.03	1.61	0.60	5.62	1.24
WHITBY (PRINGLE CREEK 2)	0.91	6.29	2.09	0.84	6.59	2.01
	0.85	2687.59	832.92	0.80	2795.13	815.93

PREDICTED LOADINGS FOR SCENERIO 3 - LAKE ONTARIO / ST. LAWERENCE DRAINAGE BASIN

Monthly compliance: > 200,000 m3/d - 0.9 mg/L; all others - 1 mg/L.	1984			1985		
PLANT	AGGREGATE AVG. EFF. TP CONC. (mg/L)	AVERAGE DAILY Q (1000 m3/d)	TOTAL P LOADING (tonnes/yr)	AGGREGATE AVG. EFF. TP CONC. (mg/L)	AVERAGE DAILY Q (1000 m3/d)	TOTAL P LOADING (tonnes/yr)
BELLEVILLE	0.67	46.23	11.30	0.49	39.91	7.18
BROCKVILLE	0.92	14.68	4.94	0.75	18.51	5.06
BURLINGTON (SKYWAY)	0.62	87.54	19.76	0.63	64.91	15.03
CALEDON (BOLTON) **	0.51	3.52	0.66	0.43	4.10	0.65
CAMPBELLFORD	0.68	7.12	1.77	0.77	6.66	1.86
COBOURG (1)	0.51	12.96	2.42	0.68	8.50	2.12
CORNWALL (CORNWALL)	0.89	48.46	15.72	0.91	47.64	15.75
DUNDAS **	0.76	12.75	3.52	0.70	13.33	3.42
FORT ERIE (ANGER AVE.)	0.70	12.84	3.29	0.72	12.92	3.39
GRIMSBY (BAKER ROAD)	0.70	10.73	2.74	0.56	10.75	2.21
HALTON HILLS (ACTON) **	0.48	3.40	0.59	0.46	3.92	0.66
HALTON HILLS (GEORGT.)**	0.85	9.96	3.08	0.50	11.14	2.02
HAMILTON (WOODWARD)	0.88	323.09	103.61	0.84	307.78	94.60
IROQUOIS	0.88	3.19	1.02	0.97	4.46	1.57
KINGSTON TWP.	0.86	15.55	4.89	0.86	16.33	5.11
KINGSTON	0.93	57.26	19.38	0.76	66.43	18.50
LINDSAY LAGOON	0.45	12.89	2.12	0.46	18.33	3.09
METRO TORONTO(HIGHLAND)	0.85	156.83	48.48	0.76	163.35	45.42
METRO TORONTO(HUMBER)	0.88	339.27	109.34	0.82	377.69	113.35
METRO TORONTO(MAIN)	0.85	676.22	208.62	0.86	683.07	213.76
METRO TORONTO(N.TORONTO)	0.83	35.77	10.87	0.81	34.69	10.23
MILTON **	0.32	9.89	1.15	0.27	12.32	1.23
MISSISSAUGA (CLARKSON)	0.88	75.27	24.05	0.88	71.11	22.95
MISSISSAUGA (LAKEVIEW)	0.79	198.62	56.93	0.65	230.41	54.38
NAPANEE	0.98	6.02	2.16	0.98	6.22	2.22
NEWCASTLE(PORT DARLINGT)	0.91	6.40	2.13	0.84	8.07	2.49
NEWMARKET	0.00	0.00	0.00	0.00	0.00	0.00
NIAGARA FALLS (STAMFORD)	0.62	56.10	12.60	0.45	57.01	9.45
OAKVILLE (SE)	0.81	12.48	3.67	0.77	13.27	3.71
OAKVILLE (SW)	0.78	24.79	7.07	0.76	28.92	8.04
ORANGEVILLE **	0.35	7.32	0.95	0.25	8.10	0.74
OSHAWA (HARMONY CR.1)	0.78	25.86	7.35	0.57	27.49	5.77
OSHAWA (HARMONY CR.2)	0.79	26.60	7.65	0.50	27.59	5.04
PETERBOROUGH	0.75	54.50	14.94	0.70	55.62	14.21
PICKERING (DUFFIN CREEK)	0.92	121.05	40.66	0.89	149.65	48.83
PICTON	0.51	3.15	0.59	0.51	3.31	0.62
PORT COLBORNE (SEAWAY)	0.84	14.08	4.32	0.81	13.19	3.88
PORT HOPE	0.51	8.35	1.55	0.57	9.56	1.99
PRESCOTT (EDWARDSBURGH)	0.88	4.42	1.43	0.62	5.15	1.16
ST.CATHARINES (P.DALH.)	0.54	32.40	6.40	0.39	41.53	5.86
ST.CATHARINES (P.WELLER)	0.57	35.83	7.43	0.75	41.99	11.50
TRENTON	0.55	10.80	2.17	0.57	11.15	2.33
WELLAND	0.36	40.16	5.35	0.70	33.44	8.57
WHITBY (CORBETT CREEK)	0.82	10.92	3.27	0.59	13.41	2.87
WHITBY (PRINGLE CREEK 1)	0.73	6.03	1.61	0.60	5.62	1.24
WHITBY (PRINGLE CREEK 2)	0.91	6.29	2.09	0.84	6.59	2.01
	0.81	2687.59	795.65	0.77	2795.13	786.07

PREDICTED LOADINGS FOR SCENERIO 4 - LAKE ONTARIO / ST. LAWERENCE DRAINAGE BASIN

Monthly compliance for all plants: TP = 0.9 mg/L	1984			1985		
PLANT	AGGREGATE AVG. EFF. TP CONC. (mg/L)	AVERAGE DAILY Q (1000 m3/d)	TOTAL P LOADING (tonnes/yr)	AGGREGATE AVG. EFF. TP CONC. (mg/L)	AVERAGE DAILY Q (1000 m3/d)	TOTAL P LOADING (tonnes/yr)
BELLEVILLE	0.65	46.23	10.97	0.49	39.91	7.18
BROCKVILLE	0.86	14.68	4.62	0.72	18.51	4.87
BURLINGTON (SKYWAY)	0.61	87.54	19.50	0.62	64.91	14.77
CALEDON (BOLTON) **	0.51	3.52	0.65	0.43	4.10	0.64
CAMPBELLFORD	0.67	7.12	1.75	0.74	6.66	1.79
COBOURG (1)	0.48	12.96	2.29	0.65	8.50	2.01
CORNWALL (CORNWALL)	0.85	48.46	15.08	0.86	47.64	14.98
DUNDAS **	0.72	12.75	3.37	0.67	13.33	3.24
FORT ERIE (ANGER AVE.)	0.67	12.84	3.14	0.70	12.92	3.31
GRIMSBY (BAKER ROAD)	0.68	10.73	2.68	0.55	10.75	2.17
HALTON HILLS (ACTON) **	0.46	3.40	0.57	0.46	3.92	0.66
HALTON HILLS (GEORGT.)**	0.81	9.96	2.93	0.50	11.14	2.02
HAMILTON (WOODWARD)	0.88	323.09	103.61	0.84	307.78	94.60
IROQUOIS	0.82	3.19	0.95	0.89	4.46	1.45
KINGSTON TWP.	0.82	15.55	4.64	0.83	16.33	4.92
KINGSTON	0.89	57.26	18.64	0.76	66.43	18.50
LINDSAY LAGOON	0.44	12.89	2.06	0.45	18.33	3.01
METRO TORONTO(HIGHLAND)	0.85	156.83	48.48	0.76	163.35	45.42
METRO TORONTO(HUMBER)	0.88	339.27	109.34	0.82	377.69	113.35
METRO TORONTO(MAIN)	0.85	676.22	208.62	0.86	683.07	213.76
METRO TORONTO(N.TORONTO)	0.80	35.77	10.39	0.78	34.69	9.90
MILTON **	0.32	9.89	1.15	0.27	12.32	1.23
MISSISSAUGA (CLARKSON)	0.85	75.27	23.32	0.85	71.11	22.12
MISSISSAUGA (LAKEVIEW)	0.79	198.62	56.93	0.65	230.41	54.38
NAPANEE	0.89	6.02	1.96	0.89	6.22	2.03
NEWCASTLE(PORT DARLINGT)	0.85	6.40	1.98	0.82	8.07	2.41
NEWMARKET	0.00	0.00	0.00	0.00	0.00	0.00
NIAGARA FALLS (STAMFORD)	0.61	56.10	12.45	0.45	57.01	9.45
OAKVILLE (SE)	0.77	12.48	3.52	0.72	13.27	3.49
OAKVILLE (SW)	0.75	24.79	6.77	0.72	28.92	7.60
ORANGEVILLE **	0.35	7.32	0.95	0.25	8.10	0.74
OSHAWA (HARMONY CR.1)	0.72	25.86	6.83	0.56	27.49	5.60
OSHAWA (HARMONY CR.2)	0.73	26.60	7.10	0.50	27.59	5.04
PETERBOROUGH	0.72	54.50	14.29	0.67	55.62	13.67
PICKERING (DUFFIN CREEK)	0.87	121.05	38.57	0.84	149.65	45.86
PICTON	0.50	3.15	0.58	0.51	3.31	0.62
PORT COLBORNE (SEAWAY)	0.78	14.08	3.99	0.76	13.19	3.65
PORT HOPE	0.51	8.35	1.55	0.57	9.56	1.99
PRESCOTT (EDWARDSBURGH)	0.84	4.42	1.36	0.62	5.15	1.16
ST.CATHARINES (P.DALH.)	0.54	32.40	6.40	0.39	41.53	5.86
ST.CATHARINES (P.WELLER)	0.57	35.83	7.43	0.73	41.99	11.22
TRENTON	0.54	10.80	2.14	0.57	11.15	2.33
WELLAND	0.36	40.16	5.35	0.68	33.44	8.33
WHITBY (CORBETT CREEK)	0.78	10.92	3.11	0.58	13.41	2.83
WHITBY (PRINGLE CREEK 1)	0.70	6.03	1.54	0.59	5.62	1.21
WHITBY (PRINGLE CREEK 2)	0.86	6.29	1.97	0.79	6.59	1.90
	0.80	2687.59	785.53	0.76	2795.13	777.27